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## WATER RESOURCES AND SUPPLIES

incorporated into its risk analysis caused a further delay. The proposed arsenic rule is due in November 1995. A maximal contaminant level goal of zero is expected. The maximal contaminant level would be substantially lowered from 0.05 mg per litre and was expected to be between 2 and 20 µg per litre. The technical and commercial feasibility of various technologies for treating arsenic to very low concentrations would be assessed. A national arsenic occurrence survey was being carried out to provide a statistically valid national estimate of low level arsenic occurrence. U.S.A.

95-0008

### **Arsenic occurrence: USEPA seeks clearer picture.**

J. REID (American Water Works Association)

*Journal of American Water Works Association*, 1994, **86**, No 9, 44-51

The assessment of arsenic's health effects was important to the development of a revised arsenic rule. Existing health effects studies are reviewed. Several recent surveys were particularly important because they used analytical methods with detection limits of 0.5-1.0 µg per litre which provided more precise information on systems with low arsenic concentrations. Preliminary estimates indicated that arsenic occurred primarily in groundwater systems in the western United States, serving fewer than 10 000 people. U.S.A.

95-0009

### **The fourth revision of the Effluent Taxation Law - nature of the changes and the intentions of the legislators**

P. M. SCHULTZ (Rechtsanwalt, Köln)

*Korrespondenz Abwasser*, 1994, **41**, No 9, 1613, 1614 and 1616, 1617 (in German, English summary)

The nature of the amendments embodied in the 4th revision of the Effluent Taxation Law is reviewed, the intention being to moderate some of the burdens on dischargers while introducing special provisions to mitigate the consequences for manufacturers in the eastern territories (formerly the GDR). The modifications involve a slower rate of rise in the scale of charges than that envisaged in earlier editions, coupled with wider concessions regarding the opportunities for offsetting capital expenditure on new plant or sewerage systems against the charges based on the pollution load. In this way the provision of finance for the rehabilitation of decaying sewerage networks is rendered easier providing certain conditions are fulfilled. Extended set-off provisions are made in the case of the eastern territories; the actual unit charge in these areas is limited and an extended time scale (up to 5 years) is allowed for implementation of taxation financed treatment installations. (English translation, 150 pounds sterling, valid for 1995). Germany

95-0010

### **A watershed event in water quality protection**

P. L. FRIEDMAN (Inno Tech, Inc., Ann Arbor, Mich.), D. W. DILKS, G. W. DUKES, and W. A. KREUTZBERGER

*Water Environment & Technology*, 1994, **6**, No 9, 76-81

The evolution in the U.S.A. of ever broader regulatory policies to ensure the restoration and maintenance of good quality surface waters is outlined. Attention is focused primarily on Federal and State Government enactments from about the mid 1960s onwards, with secondary attention to the endeavours of professional organizations and local associations formed for specific water quality related purposes. The gradual recognition that controls on point sources of pollution would not, by themselves, be sufficient to clean up surface waters, but that control of non-point sources was of at least equal importance, was seldom supported by adequate funds to permit the

latter to be monitored, let alone prevented. The concept of a water body's ability to accept only a total daily maximal load of pollution was the key to action on a watershed wide scale but unified, standardized and concurrent actions have been difficult to implement, partly because discharge permits expired at different times, and they often been granted when the limits for water quality had been set at different values. Nevertheless, examples of some state wide or local action programmes based on the concept exist, and are quoted. Future management plans may include controls on other than purely chemical and micro-biological factors; for example, it may be necessary to enforce channel dredging, re-vegetation, eradication of invasive exotic species, restoration of habitats, immobilization of contaminants in sediments, and reduction of atmospheric contaminant deposition. U.S.A.

95-0011

### **Increasing regulations result in decreasing operational efficiency.**

C. W. GRANZ (Gulf Coast Waste Disposal Authority, Houston, Tex.) and R. L. BROWN

*Water Science & Technology*, 1994, **29**, No 8, 149-152

The deleterious effect of detailed legislation since the Clean Water Act (CWA) of 1972 on efficient waste water treatment are explained. One damaging regulation under Section 307 (b)(1) affected the status of 4 plants which the Gulf Coast Waste Disposal Authority was using to treat industrial effluents. Pre-treatment conditions were imposed on wastes discharged to the works which assumed no removal of toxic pollutants occurred. This rendered such works no value to industrialists who had to pre-treat to high standards wherever these effluents were discharged. Special legislation eliminated these restrictions in 1992. Another act, the Resource Conservation and Recovery Act, deemed that the mixing of hazardous and non-hazardous wastes resulted in a hazardous waste even where this was demonstrably untrue. This had prevented the cost effective disposal of an acidic waste. Legislation in this field seemed to be driven by politics rather than sound technical considerations. U.S.A.

95-0012

### **EC proposal on ecological quality of surface waters out at last**

*WDS Report*, 1994, No 235, 36-37

A draft Directive created a framework for Member States to improve the ecological quality of all surface waters by addressing all pollution sources and pollutants. Member States would have to set up measurement and monitoring systems to determine and classify the ecological quality of surface waters, carry out a pollution inventory, define operational targets, and adopt, publish and implement integrated programmes. Subsidiarity could be a major issue with Member States being given discretion in setting water quality improvement targets. The proposal's definition of good ecological quality would also be a major issue. Europe

95-0013

### **Transposing the 1991 EC Directive into French law**

J. L. LAURENT (Ministère de l'Environnement)

*Techniques Sciences Methodes*, 1994, **89**, No 7/8, 384-387 (in French)

The major significance of the EC Directive 91/271/EEC dated 21 May 1991 concerning the collection and treatment of municipal sewage is discussed, with particular reference to its implications for French sewage undertaking and the manner in which the Directive is being embodied in the French national legal codex. The fundamen-

cal principles of this process and the manner in which the Directive will be applied under the broad provisions of the French Water Law of 3 January 1992 are outlined and certain sensitive geographical areas where a rigorous standard of treatment is required are identified. (English translation 130 pounds sterling, valid for 1995).

France

#### 95-0014

##### **The design of sewage treatment plants complying with the EC Directive: initial lessons.**

J. WALCH (Agence de l'eau Adour Garonne)

*Techniques Sciences Methodes* 1994, 89, No 778, 388-389 (in French)

A part of the process involved in the adoption of the EC Directive concerning the treatment of municipal wastewaters as it affects French sewage undertakings, a study was initiated under the direction of the Adour Garonne River Basin Agency, of the implications of the Directive for the design of sewage treatment plants. The extent to which existing treatment plants, especially those of the extended aeration activated sludge type, are capable of fulfilling the treatment objectives laid down by the Directive is briefly discussed and certain criteria are set out for the proper design of future treatment plants. These involve an accurate characterization of all the effluent streams entering the plant, and adequate provision for surface runoff under wet weather flow conditions. In addition, greater attention must be paid to the reliability of plant performance, both as regards biological activity and also the electrical and mechanical fittings and equipment. (English translation 80 pounds sterling, valid for 1995).

France

#### 95-0015

##### **Urban sewerage targets for tomorrow**

J. BALAY (Ecole nationale d'ingenierie rural des eaux et des forêts)

*Techniques Sciences Methodes* 1994, 89, No 778, 390-391 (in French, English summary)

The adoption of the recent EC Directive concerning the treatment of municipal wastewater, coupled with the implementation of the 1992-1996 five-year programme of improvements already initiated by the French River Basin Agencies, will have long-lasting effects on the standards of sewage treatment for municipal authorities in France. The consequences of the improved water quality standards imposed by the Directive are briefly discussed, and involve a greater degree of centralized collection and management of wastewater flows with treatment in plants of greater efficiency and reliability, and the introduction of new treatment plants capable of blending with the surrounding environment. (English translation 60 pounds sterling, valid for 1995).

France

#### 95-0016

##### **New constraints imposed on the operation of sewage treatment plants**

J. C. CORNIER (SAUR France), C. LAYOL, A. TESQUE, J. P. VILLESSOT

*Techniques Sciences Methodes* 1994, 89, No 778, 392-406 (in French, English summary)

The implementation of the May 1991 EC Directive concerning the treatment of municipal wastewaters will have important consequences for the operation of sewage treatment plants, and some of the implications for the control of sewage treatment facilities for the larger towns and cities in France are examined. The Directive envisages the provision of adequate treatment for all wastewaters and the

attainment of the specified treatment objectives for 95 per cent of the time. Treatment capacity must be sufficient to cater for both foul sewage and stormwater, in order to avoid direct discharges except under exceptional circumstances, and the treatment performance will no longer be assessed with respect to mean values for effluent quality but on the basis of peak levels for the stipulated parameters, and the results of quality monitoring must be accessible to public inspection. The manner in which these stipulations will affect the operational control of various sections of a large treatment plant, involving the actual values of the relevant quality parameters and the impact of increased hydraulic loadings on the compliance with specified limits, are discussed in depth. Implications for the storage and treatment of sewage sludge are also considered. (English translation 540 pounds sterling, valid for 1995).

France

#### 95-0017

##### **Disposal discord down on the farm**

A. SEABYE (ISWA, Denmark)

*Water & Environment International* 1994, 3, No 10, 36-37

The uncertainties arising from the widely differing national policies on sludge spreading are examined. The frequent anomalies between U.S. legislation, EC recommendations and regulations throughout Europe, and Scandinavian practices, are discussed. Regulations relating to heavy metals content and to nutrient levels of sludge are examined. The need for a long-term strategy founded on scientifically based assessments to provide a foundation for effective standardized regulation is discussed.

Europe

#### 95-0018

##### **EPA policy charts the course for CSO control**

H. C. ANDREWS, Black & Veatch, Kansas City, Mo., and S. E. JOHN

*Public Works* 1994, 125, No 10, 74-76 and 130

The U.S. EPA Combined Sewer Overflow (CSO) policy, issued in April 1994, is outlined, and the 9 minimal controls within this policy are summarized. The implications of the policy for cities in the U.S.A. are examined, particularly the pre-emption or demonstration approach, cost, performance, and affordability, and wet weather water quality standard. These 9 minimal controls had to be met by the February 1995 deadline. Community planning had an important role in ensuring that CSO facilities were compatible with existing or potential shoreline uses, and for the elimination or relocation of overflow-to-sensitive areas. More information on implementing the CSO control policy is provided in U.S. EPA guidance documents.

U.S.A.

#### 95-0019

##### **Ensuring safer drinking water**

J. CHRISTENSEN (Advanced Customer Systems, L.P., St. Louis, Mo.) and P. HIGGINS

*Public Works* 1994, 125, No 10, 46-47

The creation and development of the Drinking Water Additive Programme by NSF International (formerly the National Sanitation Foundation of Ann Arbor, Mich.) is described. The programme was designed to evaluate the health effects of drinking water additive products and services which come into contact with potable water during treatment, storage, transmission or distribution. Based on this programme, the development and requirements of ANSI/NSF standards 60 and 61 are discussed. The scope of the standards is also given. Testing depended on following several procedures, and having every component of a potable water system certified to comply with the overall standard requirement.

U.S.A.

## WATER RESOURCES AND SUPPLIES

95-0020

### **The joint water undertaking for the 'South Vienna Basin'.**

#### **Tasks and objectives.**

K. KOEHL

*Ges. Wayer/ Wayer, 1994, 48, No 9: 299-304 (in German)*

The joint water undertaking for the South Vienna Basin district was formally incorporated on 27 November 1992 and its first general meeting was held on 25 February 1993. The events leading up to the formation of this new water supply organization are recounted, originating from studies commenced shortly after World War II and formally recognized as a possibility in a report dated 21 February 1950 regarding water supply in the Vienna-Vienna Neustadt district. The new organization now includes 5 major waterworks and supplies almost 300 000 inhabitants with an annual total of 32 million m<sup>3</sup> of drinking water. Some of the problems confronting the new organization are discussed, especially those relating to groundwater contamination and the future protection of its sources of water for supply. (English translation 230 pounds sterling valid for 1995). **Austria**

95-0021

### **The consent contract for effluent discharges.**

C. D. BAYES (Forth River Purification Board, Alloa)

*Journal of Institution of Water and Environmental Management* 1994, 8, No 4: 417-424

The purpose of a contract between a discharger and a regulator is reviewed and compared with effluent performance characteristics. The evolution of consent conditions and compliance assessment in Scotland is described. Challenges associated with the implementation of the urban wastewater treatment Directive are considered. A new framework for the consent contract is proposed for sewage discharges and its application to industrial discharges is considered. The new contract prescribes required effluent performance, authorizes non-compliance and includes an explicit assessment of compliance. An appendix details a consent contract for a qualifying works under Directive 91/271/EEC. **U.K.**

95-0022

### **The sewage works manager - an industrialist's friend or foe?**

P. MATTHEWS (Anglian Water Services Limited, Cambridge)

*Water Science & Technology* 1994, 29, No 8: 135-147

The service provided by a wastewater treatment organization for trade effluent discharges and the constraints imposed to protect treatment processes are discussed with emphasis on U.K. experience. The need to control the flow and quality of trade effluent entering sewers and the principles underlying the setting of discharge standards are considered. Charges, monitoring, administration, legal sanctions and the principal parameters controlled are outlined. In general, the relationship between an effective water utility and a responsible industrialist would be one of co-operation not antagonism as both should be striving to protect the environment. **U.K.**

95-0023

### **Laboratory information management systems for the 90s.**

T. W. GARRETT (Weston Engineering Inc., San Jose, Calif., U.S.A.) and R. B. HUNSINGER

*Water Supply* 1994, 12, No 1/2: SS 81-SS 84

Most water quality laboratories used laboratory information management systems (LIMS) developed in response to greatly increased workloads caused by strict regulatory activity. Their major functions ranged from sample collection scheduling, the capture of analytical data, quality assurance, laboratory management, cost accounting and the dissemination of data. LIMS were composed of numerous

sub-sections and needed to interface with other information and management systems in an organization. The most important of these were systems of surveillance, optimization of processes and provision of real time information. Further improvements in integration with other networks, an enhanced database, the application of expert systems and the possibility of audit trails were desirable. **North America**

95-0024

### **An integrated strategy for dealing with diffuse pesticide pollution by catchment control and treatment.**

R. A. BREACH (Severn Trent Water Ltd, Birmingham), and M. J. PORTER

*Water Supply* 1994, 12, No 1/2: SS 91-SS 97

A strategy had been developed in Severn Trent Water's catchments to control pesticides and comply with the EC standard of 0.1 µg per litre in drinking water. Pesticide use in catchments was evaluated in detail from information on crops, likely pesticide application rates and actual sales. Raw waters were regularly sampled and analysed. All users were alerted to the dangers to water quality posed by residual herbicides applied to hard surfaces. Methods of application which minimized water pollution had been devised. Catchment protection policies were being formulated for all impoundment reservoirs. National regulatory controls had been extended to ban the non agricultural use of simazine and atrazine. The vulnerability of catchments to pesticide pollution had been assessed. Pesticides reaching waterworks were generally treated by granular activated carbon filtration, although treatments based on ozone were also being considered. The ultimate aim was to control pesticide use by voluntary and statutory means so that treatment was unnecessary. **U.K.**

95-0025

### **Dynamic control of wastewater treatment plants**

J. E. ANDREWS (Rice University, Houston, Tex.)

*Environmental Science & Technology* 1994, 28, No 9: 434A-440A

Applications of dynamic modelling, computer simulation and control systems to wastewater treatment works are reviewed. Because of the strong interactions between process design and process control, process design must be integrated with control system design to optimize overall performance. The potential benefits of dynamic modelling and computer control included improvements to productivity, performance, process stability and reliability, reductions in operating and maintenance costs and personnel requirements, and better start up procedures. Feedback control, feed forward control and combined control methods are distinguished. The role of expert systems is considered. There are 30 references. **U.S.A.**

95-0026

### **System of environmentally compatible plant management for effluent-intensive production units as a method of averting damage to the environment.**

D. KALAITZIS (Dr Kalaitzis & Partner GmbH, Dortmund), T. GILASER and K. JODICKI

*GWF Wayer/Abwasser* 1994, 135, No 9: 534-541 (in German, English summary)

The importance of systematic monitoring and preventive action as a method of reducing the risk of environmental pollution in the course of manufacturing and processing operations is discussed. It has assumed an overriding importance in view of penalties for infringement of effluent quality standards or accidental discharge of contaminants, aided by growing ecological awareness among the

general public. The various safety and health-related tasks associated with the operation of a factory are reviewed and a unified system of co-ordinating all aspects of occupational health and environmentally relevant activities is proposed. Particular danger points should be identified and instructions drawn up for use in the event of spillages and also for reducing the risks associated with normal factory operating procedures, such as the problems at the man/machine interface where periodical topping up with chemicals or working substances may be called for. The organization of a documentation system covering all such situations is outlined, as are several approaches towards the development of cleaner and more environmentally friendly factory procedures. (English translation 275 pounds sterling, valid for 1995). **Germany**

#### 95-0027\*

##### **Integrated control system for the management of water resources in the Roja and Argentina catchments.**

N. CAVALIERE (AAMAF, San Remo), O. CONIO and R. CALIGARIS

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille, France, Volume 2, 1994, 311-317 (in French, English summary).*

The management of water resources for the production of drinking water by the utility undertaking for San Remo in the province of Liguria is being assisted by the introduction of an integrated basin management system for the Roja and Argentina basins. The system comprises a decision support model and a field data acquisition module, the former being the intelligent core of the combined system. The information concerning water level fluctuations will be derived from monitoring equipment installed in both basins and the data will be utilized in conjunction with rainfall measurements to predict the variability of available supplies, supported by an aquifer model calibrated with reference to historical data. The results will be processed at the regional control centre and ensuing decisions will be communicated to the local control centres by a telecommunications network, which can also be used to provide access to the decision support system when required to deal with local emergencies. **Italy**

#### 95-0028\*

##### **SI-MO Sludge utilization and management operation**

D. W. BLACK (Sewern-Trent Water Ltd)

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille, France, Volume 2, 1994, 387-389 (in English).*

In order to monitor and record all sludge movements and compositional data within the Severn-Trent area of operations, a user-friendly computer system has been designed for sludge utilization and management operations (SI-MO). This system is capable of storing and retrieving information relating to sludge collection and transport, sludge movements within treatment works and sludge disposal operations, including details of previous sludge spreading and application rates for any given site. The system is linked to the QULS quality information system which contains all the analytical data from the laboratories responsible for sludge quality monitoring. The system is designed to ensure that all the stipulations embodied in the EC Directive regarding the application of sludge to land, together with the UK Codes of Practice are adhered to and that maximal permissible limits for metals, nutrients and rates of application at any given site are not exceeded. Brief details of the type of hardware and software systems involved are included. **U.K.**

#### 95-0029\*

##### **ADAGES - decision support system for groundwater management.**

W. TRECHET (Bureau de Recherches Géologiques et Minières, Orleans) and S. C. MAUNOUSSI

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille, Volume 2, 1994, 486-489 (in English).*

A microcomputer based decision support system (DSS) for groundwater management is described which can be applied to situations where multiple conflicting goals cannot be resolved by deterministic methods. The DSS employs a system for multiple criteria decision making coupled with groundwater modelling. The package consists of several separate modules which are linked together in such a way that a set of possible solutions can be identified and presented to the decision maker as a basis for an informed decision on the ultimate preferred solution. The mode of operation of the program and its stepwise implementation are described with the aid of a flow chart illustrating the progressive stages in the situation and optimization of the results and their presentation in numerical or graphical format. **France**

#### 95-0030

##### **Design rules and costs applicable to sewage treatment plants in northern Europe**

P. WEINER (Agence de l'Eau Rhin-Meuse, France)

*Techniques, Sciences, Methodes, 1994, 89, No 7/8, 401-416 (in French, English summary).*

A comparative study of the design and performance criteria applicable to sewage treatment plants in 4 northern European countries (France, Germany, Holland and Switzerland) is presented. The study involved a survey of 5 typical treatment plants of similar size together with a comparison of proposals relating to the design of a new treatment facility with a capacity of 50 000 PE, submitted by representatives from each of the countries concerned. The relevant technical data are summarized and an overview of the present practice of sewage treatment and plant design in the several countries is presented. The 4 countries outside France have tended to adopt a practice of over-dimensioning of treatment facilities in the recent past, a trend which is now being reversed in the interests of economy and efficiency. The implications for future design of French treatment plants are discussed in view of the new EC Directive, and a better balance of capital investment between the sewerage system and the treatment plant is considered desirable. (English translation 270 pounds sterling, valid for 1995). **Europe**

#### 95-0031

##### **Responsibilities of water supply undertakings: continuity of service and firefighting needs**

C. PIERRE (Compagnie Générale des Eaux) and J.

BLISSART

*Techniques, Sciences, Methodes, 1994, 89, No 7/8, 423-426 (in French, English summary).*

The responsibilities of water supply undertakings towards their customers with respect to reliability and continuity of the supply under the terms of French law are discussed. The legal position affecting both planned and unplanned interruptions in the supply is reviewed, and the general principles applicable to all users, and also those with contractual agreements with the undertaking, are outlined. In addition, the responsibilities attaching to the undertaking for the supply of water for firefighting purposes are considered in view of both technical and financial constraints. While existing arrangements have generally worked in practice, there is a need for more precise



## WATER RESOURCES AND SUPPLIES

definition of the obligations of the water suppliers in this area, which will shortly be forthcoming (English translation 165 pounds sterling valid for 1995). **France**

**95-0032**

### **An environment agency to avoid the pitfalls of the past.**

P. GARRETT

*Utility Week*, 1994, 23 September, 18-19

Lord Crickhowell, Chairman of the National Rivers Authority (NRA), considered that the relationship between the environmental and economic regulators had not been properly thought out upon water privatization. There was a lack of proper debate during the recent price review and much that the NRA regarded as important foundered. There was an urgent need for review and reform. The new environment agency would represent a more integrated approach to environmental regulation, but conflicts between regulators needed to be resolved first. **U.K.**

**95-0033**

### **Public-private partnership and process modification enhance operations.**

G. H. COBURN (Environmental Management Corporation, St. Louis, Mo.)

*Water Engineering & Management*, 1994, 141, No 9, 28-30

The arrangements between a private company and Evansville, Ind., for the operation of sewage works are explained. The contract, which restricted the liability of the city for maintenance, labour and energy costs, required the contractor to achieve effluent quality standards. Other conditions related to computer system development, safety training and sludge disposal. The arrangement had saved over \$60,000 (U.S. dollars) and had not been detrimental to staff conditions of employment. **U.S.A.**

**95-0034**

### **Biosolids management demands all-around attention**

J. NELSON (Professional Services Group Inc., Houston, Tex.) and P. WERNSDORFER

*Water Engineering & Management*, 1994, 141, No 9, 48-50

The role of sludge management in avoiding regulatory breaches, odour problems, and excessive operating costs is discussed. The factors for successful operation are considered, especially the integrated view of the whole treatment process. Control of industrial discharges, thorough preventive maintenance and adequate monitoring are also essential. Good performance further depends on a trained workforce, skilled in community relations. **U.S.A.**

**95-0035**

### **Use of ICA for water treatment and water quality monitoring.**

F. CUBILLO (Canal de Isabel II, Madrid, Spain)

*Water Supply*, 1994, 12, No 1/2, IR 8-1, IR 8-6

An international overview, based on national reports is presented on the use of instrumentation, control and automation systems (ICA) for water treatment and water quality monitoring. Four fundamental elements are considered: monitoring requirements, instrumentation, control and data acquisition, and management information systems. Raw water treatment plants and distribution systems all required monitoring, and in some cases the parameters were dictated by regulations. Sensors were the most critical part of the instrumentation, in addition to chemical types, biosensors, immunological and polarographic sensors were being developed for automatic use. Three distinct methods of controlling treatment plants were teleme-

try, programmable logic controllers and distributed control systems. Geographical information systems were finding uses in management information systems, particularly where spatial and temporal simulations of pollutant movements were required. The full application of ICA to the water industry was rarely seen because reliability was suspect, sensor maintenance demanding, some quality parameters could not be sensed in the field, and costs often exceeded benefits. **International**

**International**

**95-0036**

### **National Report Australia.**

D. MITNAGE (Sydney Water Board, M.S.W.) and G. TRICKLETT

*Water Supply*, 1994, 12, No 1/2, IR 8-10

The use of instrumentation, control and automation systems (ICA) for water treatment and water quality monitoring is discussed from an Australian viewpoint. Limited remote catchment and reservoir monitoring already took place although further developments were planned. Several waterworks monitored the common parameters such as pH, turbidity, and chlorine residual at all stages of treatment. At Sydney, pH, chlorine residual, temperature, turbidity, pressure and flow could be monitored by mobile trailer in the distribution system and telemetered to base. **Australia**

**95-0037**

### **Water networks at the end of the 20th century.**

J. L. SOLANAS (Societat General d'Aigües de Barcelona)

*Water Supply*, 1994, 12, No 1/2, SS 7-1, SS 7-5

The efficiency of operating water distribution systems is reviewed and likely future developments considered. The complexity of operation had prevented cost reduction in the last 30 years. Data processing and automation had been insufficiently co-ordinated thus compounding the effect. This lack of integration was preventing efficiency improvements; it required links between information and geographical information systems, and extensions to the customer information system. Considerable effort was needed in project planning, systems integration and organizational design to overcome complexity and raise efficiency. **Spain**

**95-0038**

### **Preparation for emergency water supply and the relevant planning and organizing activities.**

V. VASVARI (Budapest Waterworks)

*Water Supply*, 1994, 12, No 1/2, SS 12-1, SS 12-5

Hungary did not possess the technical resources for a comprehensive response to the loss of water supplies in a major disaster. It sought to identify and register the significant hazards and the organizations which would react to disasters. Regional supervisory centres and waterworks needed to co-ordinate closely to define the measures hazardous industries had to take to prevent accidents or minimize their effects when they occurred. Continuous water quality monitoring and control were necessary. Mobile water treatment plants would be deployed in the event of a disaster. Regular training exercises were required and cross border co-operation was needed for many European countries. **Hungary**

95-0039

**Execution of water supply and sewerage tasks as a partnership between public and private organizations.**

F. SCHEUBLE (FlowNet Management and Consult GmbH, Frlingen)

*IR International*, 1994, 33, No 9, 497-504 (in German-English summary)

Present financial pressures in the public sector have severely limited the capabilities of the local and municipal authorities in the field of water supply and sewage disposal operations. The large amounts of capital required to overhaul the existing networks and the increasing technical complexity of pipelaying and rehabilitation methods have necessitated the introduction of private contractors and in many cases private capital into the planning and implementation of new sewerage and mains rehabilitation projects. The various ways in which this co-operation between public and private sector management can be achieved under German law are discussed, together with different forms of contract, including those which combine construction with operation of the system for a specified length of time. The benefits achievable from such novel working arrangements are discussed, and some practical examples of their application to sewage plant construction are outlined, including the new sewage works for Kahlia (Thuringia) of 27 700 PE rated capacity and Bad Worbis (ca. 47 000 PE). In the latter case, the works was erected for only just more than 50 per cent of the original cost estimate, and achieved a higher standard of treatment. The resulting unit charge for sewerage services was reduced from 4.30 DM per m<sup>3</sup> to only 2.08 DM per m<sup>3</sup>. (English translation 260 pounds sterling valid for 1995)

Germany

95-0040

**Special k**

J. BRINDLEY (WS Atkins)

*Water & Environment Management*, 1994, No 19, 16

The k review process is described from analysis of the company business plan, describes the k review process. The water companies had not made use of the resulting public relations opportunities. The extensive consultation had resulted in a level of understanding and stability. U.K.

95-0041

**Key changes**

E. EDWARDS

*Water Bulletin*, 1994, No 62, 1-12, 13

A flexible payment device enabled customers to pay as they go, and could be used for measured and unmeasured supply. Customers could buy a card or charge up a key at a charging point and transfer the information to the unit. At present, the budget devices were offered by 5 of the 16 water service companies but they were expected to become more widely available. The water industry group on customer issues had drawn up a code of practice on budget payment units and its principal points are summarized. Participation in a scheme must be by agreement of both the water company and the customer. U.K.

95-0042

**Policies of tariff**

W. WIEDERKEHR (Zurich Water Supply, Switzerland)

*Water Supply*, 1994, 12, No 1/2, IR 33, IR 34

An international overview of tariff policies is provided as an introduction to national reports using information from them. There was agreement that water prices should be affordable, based on metered

volumes, and that wherever possible sufficient revenue should be raised to avoid the need for subsidies. Factors influencing tariff policies were demand, the economic and industrial environments, the availability of water resources relative to the population served and the general environment. The requirements of a tariff structure for financing and covering costs, and the tariff structure itself, are summarized for several countries. Principles for formulating a tariff are proposed. International

95-0043

**The price of saving water**

O. LEBEL (Compagnie Generale des Eaux, Paris)

*Water Supply*, 1994, 12, No 1/2, SS 133, SS 134

The case for a pricing mechanism to encourage water saving rather than restrictions is explained. It was important that prices truly reflected costs. The price elasticity of demand, between minus 0.1 and minus 0.5, varied for industry and domestic consumers, the latter being relatively inflexible. However, metering encouraged reduced peak demand which usually involved luxury uses. To make pricing work, the resource had to be administratively close to end users. The selling price of water was most effectively fixed at the long term marginal cost, even if this was high. Any departure from this principle would not be as effective for reducing waste. France

95-0044

**A methodology for the evaluation of global warming impact on soil moisture and runoff**

J. B. VALDES (Texas A&amp;M University, College Station), R. S. SEOANE, and G. R. NORTH

*Journal of Hydrology*, 1994, 161, No 1/4, 389-413

The variability of soil moisture and direct surface runoff in consequence of global warming is evaluated numerically. A previously developed analytical model of the soil moisture balance was used to evaluate the probability distribution of the soil moisture concentration and the resulting surface runoff. The modelling results showed that the variability of the values around the means of distribution of soil moisture and runoff changed, as did the means themselves. The findings were immediately applicable to the planning of reservoir operation for irrigation demands and the evaluation of the change in surface runoff to be expected as a result of global warming. There are 46 references. U.S.A.

95-0045

**Managing the global environment: the role of the water manager**

R. J. LAURIN (Watermeyer, Lygse, Presold and Uhlmann, Rixtonia, South Africa)

*Water Supply*, 1994, 12, No 1/2, IR 33, IR 36

An international overview of the role of the water manager in managing the global environment is given with emphasis on climate change. Possible causes of the latter were alterations in the Earth's orbit, solar activity, fluctuations, volcanic eruptions and man's activities. The vital role of water management in influencing the environment needed to be more widely appreciated. Increased water demands would compel the use of more remote and costly sources. Pollution and other environmental damage could result and it should be part of an integrated approach to environmental management to prevent this. National reports are summarized. International

## WATER RESOURCES AND SUPPLIES

95-0046

**Climate, interseasonal storage of soil water, and the annual water balance.**

P. C. D. MILLY (US Geological Survey, Princeton, N.J.)

*Advances in Water Resources*, 1994, 17, No 1/2, 19-24

Seasonal variations and annual totals for potential evaporation and precipitation were applied in a model for annual water balance in which the only other variable of significance was the storage capacity of the soil. Seasonal sinusoidal variation of precipitation and potential evaporation was assumed and a solution to water storage was derived. The model generated a ratio of annual precipitation to potential evaporation, defined as the coefficient of dryness and 2 other dimensionless numbers, an index of the seasonality difference between precipitation and potential evaporation and a ratio between water storage and annual precipitation. An area in the U.S.A. east of 105 degrees west was used to test the model, using published data on precipitation, potential evaporation and plant available water holding capacity. The model underestimated observed runoff, less so in the more arid regions where more precipitation evaporated. The mean modelled runoff was 187 mm and the observed mean runoff was 263 mm. Factors considered to have influenced the discrepancy were spatial variation in storage capacity, the infiltration capacity of soil and the intraseasonal variability of precipitation. U.S.A.

95-0047

**Stochastic characterization of space-time precipitation: Implications for remote sensing.**

J. B. VALDES (Texas A&M University), F. H. C. YOO and G. R. NORTH

*Advances in Water Resources*, 1994, 17, No 1/2, 47-59

Characterization of the space-time variability of tropical rainfall fields was examined directly from ground sensor measurements and by use of 3 Stochastic models. This characterization was important for calibration of ground measurements, the assessment of bias in data from space borne sensors and design of satellite missions. This was carried out using a point rain gauge with contemporaneous data from the satellite sensor. This enabled errors from several rainfields to be computed, either from analytically derived and characterized ground measurements or from the data estimated spectra. This provided a lower limit to total errors, assuming perfect instruments. The isolation and evaluation of any biases that might adversely affect retrieval algorithms was also improved. U.S.A.

95-0048

**High resolution rainfall measurements by radar for very small basins: the sampling problem reexamined.**

F. FABRY (McGill University, Ste Anne de Bellevue, P.Q.), A.

BELLON, M. R. DUNCAN and G. E. AUSTIN

*Journal of Hydrology*, 1994, 161, No 1-4, 415-428

The magnitude of sampling errors in high resolution radar rainfall measurement data and the influence of these errors on sampling strategies for urban hydrology were studied. Errors due to sampling could be greater than all the other errors combined if accumulations were not properly computed. The errors could be substantially reduced, however, if the movement and development of the storms were taken into account. An accumulation method taking this into account produced accurate 5 minute accumulations for areas smaller than 1 km<sup>2</sup>. The best accumulations were obtained using very high time resolution data. Optimal spatial resolutions were also determined. Canada.

95-0049

**Scaling, soil moisture and evapotranspiration in runoff models.**

E. F. WOOD (Princeton University, N.J.)

*Advances in Water Resources*, 1994, 17, No 1/2, 25-34

The effects of microscale land surface variability on macroscale land atmosphere models has become an important focus in climatological research. High resolution land surface data have become available from remote sensing and intensive field studies of land climatology, such as HAPEX and FIFE. This has provided data to investigate the effects of microscale land atmosphere interactions in macroscale models. The scaling factor problem was addressed by derivation of a probability function for evaporation distribution. Development of a linearized second order correction algorithm that may be applicable to the parameterization of a general circulation model was carried out and evaluated. U.S.A.

95-0050

**Urban runoff: nature, characteristics and control**

R. Y. G. ANDOH (Hydro Research and Development Ltd

(Cleveland)

*Journal of Institution of Water and Environmental Management*

1993, 8, No 4, 371-378

Base flows, storm water runoff, water quality, and characteristics of pollutants in urban runoff are described. Effects of urbanization and industrialization on the hydrologic and hydraulic regimes and on water quality are discussed. Available techniques for urban runoff control are described including source control, in system control and end of system control measures. Available computer programs for the analysis and design of drainage systems, sewer flow, quantity modelling and sewer flow quality modelling are identified. The need for an integrated approach to runoff control is identified, and the cost effectiveness of such an approach is exemplified by case studies from Columbus (Georgia) and Wiltshire Forest. U.K.

95-0051\*

**Flood estimation for small catchments**

D. C. W. MARSHALL and A. C. BAYLISS

*Institute of Hydrology, Wallingford, III Report No 124, 1994*

73pp

The design and installation of a network of water level measuring devices, complete with associated data collection and storage facilities, at several small (under 25 km<sup>2</sup>) stream catchments in the area west of London are described, together with the results obtained. The methods of data analysis, and the conclusions arrived at in respect of the magnitudes of the mean annual flood flows and flood response times are outlined. The network comprised 15 stations, all of which were within the operational range of the Cheneys weather radar station monitoring the rainfall events occurring during the period of observation. The measurements were intended to remedy the previous shortage of data relating to flood events in small lowland catchments in areas of relatively low rainfall and moderate soil permeability. Each of the catchments selected for the systematic collection of data is described in detail, and the accumulated data are combined with data sets from other sources (e.g. ADAS catchments) in the overall analysis. U.K.

95-0052\*

**The source hydrology of severe sustained drought in the south-western United States.**

D. G. TARBOTON (Utah State University, Logan)  
*Journal of Hydrology*, 1994, 161, No 1/4, 31-69

The likelihood of drought in the area served by the Colorado river south western (U.S.A.) was investigated. Drought scenarios were developed using estimates of historic stream flow and reconstructions of flow based on tree ring widths. The scenarios were defined on the basis of annual flow at Lees Ferry, Ariz. on the Colorado river. Input for a system simulation model was developed by disaggregating the Lees Ferry flow to monthly flows at 29 source locations required by the model. Stochastic models were used to assess the risk in terms of return period of the scenarios developed. The risk of severe sustained drought occurring in the Colorado river basin and in southern California concurrently was also assessed. There are 39 references. U.S.A.

95-0053

**The role of soil water in stormflow generation in a forested headwater catchment: synthesis of natural tracer and hydrometric evidence.**

D. L. BAZE-MORE (Virginia University, Charlottesville), K. N. FISHLEMAN and K. J. HOLLENBECK  
*Journal of Hydrology*, 1994, 162, No 1/2, 47-75

A 3-component, 2-tracer hydrographic separation model was applied to estimate stormflow contributions from pre-event soil water, pre-event groundwater and event water for 2 storm events in a small (8.1 ha) forested headwater catchment during a 6-month period. Hydrograph separation based on naturally occurring oxygen-18 and chloride, and hydrometric data showed that pre-event soil water contributions of 36 per cent total runoff and 65 per cent peak flows for a large June storm and 25 per cent total runoff and 50 per cent peak flow for a smaller November storm were larger than previous results. Monte Carlo error analyses showed considerable uncertainty in the hydrograph separations. Results for the June storm were consistent with a sharp hydrograph response that occurred when a transient saturated zone developed above the soil bedrock interface on a 3% slope. The November storm represented a delayed response in which increased discharge could occur 8 h after precipitation ended. Water collected in zero-tension lysimeters during storms maintained isotopic signature of pre-event soil water which was probably the major component of transient saturated zones. Pre-event soil water could be more important than groundwater for generating peak runoff in steep forested catchment. There are 41 references. U.S.A.

95-0054

**Predicting sediment yield in storm-water runoff from urban areas**

T. W. HASTER (Freese and Nichols, Inc., Fort Worth, Tex.) and W. P. JAMES

*Journal of Water Resources Planning and Management*, 1994, 120, No 5, 630-650

An event-based numerical model was developed to simulate the sediment load in stormwater runoff contributed from each of the major land surface types occurring in urban catchments. Results obtained by modelling erosion data showed that the sediment yield from bare soil areas could be determined using the complete conservation of mass equation for sediment transport. Application of the proposed model to 4 small (1.1-150 ha) urban catchments consisting of grass areas and 39-86 per cent impervious areas demonstrated

good agreement between simulated and observed hydrographs particularly for smaller and more impervious catchments and larger storm events. Sediment build-up depended on antecedent time between storm events and there was a significant correlation between sediment wash-off from impervious areas and the antecedent time since rainfall last occurred. For storm events with large antecedent conditions most sediment was washed off during the first part of the storm event. U.S.A.

95-0055

**Integrated water resources management - focus on drought alleviation.**

J. NIMMO (Swiss Institute of Technology, Zurich, Switzerland)  
*Water Supply*, 1994, 12, No 1, 2, 15-2, 15-7

International initiatives for improving water resources management globally and in individual developing countries are considered. The possibility that water problems might be more critical in the next century is stressed, with global warming increasing drought frequency. The nature of droughts, their consequences for various human activities and the likelihood of them becoming catastrophes requiring political action at regional level are discussed. The difficulties and likely impossibility of forecasting droughts as cyclic but periodic events are examined. The dubious value of weather or climate modification is noted. Drought impact prevention strategies with integrated water resources management using multi-objective water resources planning are described. Their advantages and pitfalls are analysed. The major obstacles to drought mitigation were social, economic and political rather than technical. International

95-0056

**Changing flood peak levels on the river Thames**

S. M. CROOKS (Institute of Hydrology)

*Water, Maritime and Energy*, 1994, 106, No 3, 267-270

The pattern of flood peak levels on the Thames river during the past 100 years is examined, and the underlying reasons for the observed variations investigated. Peak water levels recorded at 44 locks along the river were analysed using cumulative deviations from the mean. There had been a nearly constant rate of occurrence of flood events above a bank full threshold. A greater number of these events had occurred before 1940, significantly influenced by catchment rainfall. The effects of channel dredging and watercourse clearing, increasing urbanization and development of new towns, and of improved land drainage on the flood patterns are discussed. A localized decline in peak flood levels and event duration had resulted from channel dredging and flood prevention schemes. There are 31 references. U.K.

95-0057

**Seasonal and interannual variability in the properties of the surface waters of the gulf of Maine**

D. G. MOUNTAIN (Northeast Fisheries Science Center, Woods Hole, Mass.) and J. P. MANNING

*Continental Shelf Research*, 1994, 14, No 13/14, 1555-1581

The mean seasonal cycle and interannual variability of the water properties (temperature, salinity, density stratification and geostrophic circulation) of the surface layer of the Maine gulf for 1977-1987 were investigated using hydrological data from the Maine Resources Monitoring Assessment and Prediction (MARMAP) programme. The temperatures follow the seasonal warming and cooling pattern. The surface layer salinity annual cycle in the eastern Maine gulf was dominated by the winter inflow of low salinity water from the Scotian shelf and in the western gulf by the local spring runoff

## WATER RESOURCES AND SUPPLIES

The western gulf was more stratified in summer and less stratified in winter than the eastern gulf, due to different phasing of the salinity cycle. In winter the western gulf becomes nearly uniform in density for the upper 150 m, indicating the potential for vertical mixing of nutrients from depth into the surface layer. There was relatively little temperature variability ( $\pm 2^\circ\text{C}$ ) during 1977-1987. The interannual variability in salinity of the surface layer (0-4 psu) is nearly as large as the amplitude of the annual cycle of salinity. The discharge from the St. Lawrence river affects salinity of the Maine gulf surface waters. U.S.A.

95-0058

### The impact of ambient stratification on marine outfall studies in British waters.

I. J. SHERWIN (UCNW Marine Science Laboratories Anglesey) and P. J. C. JONAS  
*Marine Pollution Bulletin*, 1994, 28, No 9, 527-533

St. Austell bay in Cornwall has extremely small tidal currents and becomes stratified in summer. The oceanography of this bay was investigated using dye and drogue releases. Diffusion coefficients were calculated from the rate of spreading and deepening of the dye patches. In relatively calm conditions (wind speed less than 4 m per second) the longitudinal diffusion coefficient increased with wind speed to more than 2 m<sup>2</sup> per second. With higher wind speeds it decreased to approximately 1 m<sup>2</sup> per second. The vertical diffusion coefficient remained small (0.0002 m<sup>2</sup> per second) at low speeds and increased to 0.0009 m<sup>2</sup> per second when the wind rose above 5 m per second. In the summer, when the winds were strong (more than 3.5 m per second) the top 5-8 m became mixed. At lower wind speeds the surface waters stratified and the circulation patterns became more complex. Usual outfall survey techniques, eg drogue float tracking, tidal analysis and two dimensional numerical modelling, have to be treated with care when applied to areas with stratified waters. U.K.

95-0059

### Hydrodynamic and ecological models for the gulf of Finland.

R. TAMSAI U (Finnish Institute of Marine Research, Helsinki), K. MYBERG and J. SARKKULA  
*Water Pollution Research Journal of Canada*, 1994, 29, No 2, 333-363

Measurements of currents and modelling simulations in the Finland gulf, a narrow sub-basin in the Baltic sea, are reviewed. The measurements indicate that a wind independent background current exists in the gulf. The impact of the large scale surface circulation on the surface currents is much reduced or disappears when there is a steep thermocline close to the surface. A two layer 2.5 D baroclinic hydrodynamic model was developed. Salinity, temperature, oxygen and nutrients have a vertical structure which was described by a homogeneous upper layer and by a self similarity profile in the pycnocline layer. The hydrodynamic model was verified against observations of salinity during the summer 1992. The FINEST aquatic ecosystem model is described. It was verified against the Baltic Monitoring Program data. The model was used to simulate phosphorus levels in the Finland gulf. There are 39 references. Finland

95-0060

### Variation in design conditions in response to sea-level rise.

I. H. TOWNEND (ABP Research & Consultancy Ltd.)  
*Water, Maritime and Energy*, 1994, 106, No 3, 205-213

Key parameters which influence coastal engineering design and ways in which these could be affected by changes in sea level are examined. The approach presented considers the relative change in each parameter as a function of the relative change in water depth. Parameters examined include wave height, wave-bed steepness and depth to wave length ratio. Structures and beach response are discussed. A general set of results for sea-level rise were obtained which were not scenario specific. General implications for shoreline management are considered. U.K.

95-0061

### Impact of Ilorin water supply expansion on the Asa river catchment.

B. F. SULE (Ilorin University) and O. F. A. OLU  
*Aqua*, 1994, 43, No 5, 246-251

The Ilorin water supply extension programme would raise water works output to 4 times existing capacity and would satisfy all needs in the city up to the year 2005. The additional raw water would come from an existing dam. The impact on the Asa river catchment was studied by a reservoir operation technique based on mass balance using present and future withdrawal rates. This indicated a reduction in potential evaporation, reduction in active storage, loss of fishing zone, reduction in available flow to downstream areas and increase in growth of aquatic vegetation. The impact would be moderate and adverse effects could be minimized. The economic benefits of the better water supply were substantial. Nigeria

95-0062

### Freshwater-inflow need of estuary computed by Texas Estuarine MAP model.

J. MATSUMOTO (Texas Water Development Board, Austin), G. HOWELL and D. BROCK  
*Journal of Water Resources Planning and Management*, 1994, 120, No 5, 693-714

A mathematical description is presented of the Texas Estuarine Mathematical Programming (TxEMP) model which was developed to protect estuarine environments in Texas by studying the effect of freshwater inflows and establishing long term ecological objectives. The nonlinear stochastic multiobjective mathematical programming model used salinity, inflow regression equations and fishery harvest-inflow regression equations to represent biological requirements, incorporated hydrological data as monthly lower and upper bounds on inflows and could include sediment and nutrient constraints. Chance constraints were incorporated for the lower and upper salinity bounds and for fishery harvest constraints. Minimal required inflow, maximal allowable inflow and maximal harvest solutions were determined for specified annual inflows, a performance curve was constructed and sensitivity analyses were performed. Application of the TxEMP model to a case of competing municipal and ecological uses of water in the Nueces estuary resulted in the establishment of a water release policy which minimized the inflow of reservoir water while satisfying salinity constraints. U.S.A.

95-0063

**The topography of optimal drainage basins.**T. SÆVI (Oslo University), P. MEAKIN and T. JOSSANG  
*Water Resources Research*, 1994, 30, No 9, 2599-2610

The modelling of drainage networks and their associated landscapes using optimization principles was investigated. A model based on the minimal energy dissipation principle and an empirical relationship between the slope of each link in a channel network and the mean annual discharge flowing through it was developed. Application of the model suggested that the surfaces of the minimal energy dissipation networks were more complex than simple self-affine fractals. Drainage basins in optimal drainage networks had power-law size distributions with a universal exponent independent of the exponent of annual discharge used in the empirical expression. There are 34 references. **Norway**

95-0064

**Data analysis of bed concentration of suspended sediment**

L. A. ZYSERMAN (Danish Hydraulic Institute, Horsholm) and J. E. PEDERSEN

*Journal of Hydraulic Engineering*, 1994, 120, No 9, 1021-1042

An empirical formulation for the bed concentration of suspended sediment defined at an elevation of a few grain diameters from the bed was derived from 10 published data sets obtained from 339 artificial channel tests involving a wide range of hydraulic parameters and bed materials. A bed load transport formula was used to separate the suspended load from the measured total load and the volumetric bed concentration was then determined using Einstein's method. Analysis of the bed concentration obtained under different physical conditions demonstrated the influence of effective shear stress, bed roughness characteristics and fluid characteristics. The influences of bed concentration effects and reference level on bed concentration values were considered and the proposed empirical relation showed satisfactory overall agreement with bed concentration values obtained from independent data. A simple method is presented for determining the total sediment transport rate using the proposed procedure for deriving bed concentration. **Denmark**

95-0065

**A reappraisal of the Kalman filtering technique, as applied in river flow forecasting.**

M. AHSAN (University College, Galway) and K. M. O'CONNOR

*Journal of Hydrology*, 1994, 161, No 1/4, 197-226

The use of the Kalman filtering technique as a tool in operational flood forecasting is critically reviewed. When the flow forecasting model was assumed to be an autoregressive moving average (ARMA) model and the associated flow data assumed to be free from measurement errors, the minimal mean square error forecasts obtained using the Kalman filtering technique were the same as those obtained using the traditional Box-Jenkins type time series forecasting method. When measurement errors were assumed, however, the use of the Kalman filtering technique became viable, though the forecast efficiency in this type of application was reduced. There are 44 references. **Ireland**

95-0066

**Identification of areas of recharge and discharge using Landsat-TM satellite imagery and aerial photography mapping techniques.**

R. B. SALAMA (CSIRO, Wembley, W.A.) and T. TAPLEY, J. ISHII and G. HAWKES

*Journal of Hydrology*, 1994, 162, No 1/2, 119-141

Complementary data from aerial photography (AP) and Landsat Thematic Mapper (TM) colour composites were used to evaluate the landforms and geological structures of the Salt river system in a 2000 km<sup>2</sup> study area. Identified geomorphic features included sandplains, dissected etchplains, colluvium, fanitic dune crest and rock outcrops. Hydrogeomorphic units consisted of streams, lakes and playas, palaeochannels and palaeodeltas, while structural features included linear and curvilinear lineaments, ring structures and dolerite dykes. Groundwater occurrence and hydrogeological classification of the recharge potential of the basin geomorphic and hydrogeomorphic units enabled the delineation of recharge and discharge areas. Suture lines controlled the river channel course and permeable areas around the circular granitic plutons were the major upland recharge areas. Recharge also occurred in the highly permeable sandplains areas while discharge was primarily along the major drainage lines, on the edge of circular sandplains, in depressions and in lakes. The results showed that TM could be used for hydrogeomorphological and structural mapping of large areas and demonstrated the importance of integrating AP, TM and hydrogeological data. **USA**

95-0067

**Streamflow forecasting for Han river basin, Korea.**

H. M. AWWAD (Freese and Nichols, Inc., Fort Worth, Tex, USA), J. B. VALDES and P. J. RESTrepo

*Journal of Water Resources Planning and Management*, 1994, 120, No 5, 651-673

The river flow forecast algorithm developed for the rainfall runoff phase of the Han river control system included linear stochastic ARMAX class models that were developed for each of the 17 sub-attachments of the river basin to produce 6 days ahead streamflow forecasts in 24 6-h steps. Optimal forecasts and updated flow estimates were obtained using the Kalman filter and 2 other filters were employed in parallel to update model parameters and noise statistical information. The flexible black box model structure allowed several exogenous inputs including precipitation, antecedent soil moisture effect, natural upstream inflows and controlled reservoir releases. Application of the proposed river flow forecasting models is illustrated by developing stochastic equations for 3 sub-attachments representing different flow categories and statistical testing of the resulting forecasts indicated satisfactory overall performance, although model parameter updating was generally not sufficiently rapid for abrupt changes in flow. **South Korea**

95-0068

**Dam truths on the Danube**

J. PEARCE

*New Scientist*, 1994, 143, No 1943, 27-31

Two years ago, Slovak engineers diverted the Danube river down a ship canal to the Gabčíkovo hydroelectric dam. Hungary claimed the diversion was illegal and both countries agreed to take their dispute to the International court, where hearings would begin in 1995. The ecological disaster which environmentalists feared has not happened and the World Wide Fund for Nature has abandoned its campaign of opposition. Past mistakes on the Danube included dredging, channelization and dam construction which halted deposition in the delta.

## WATER RESOURCES AND SUPPLIES

and the resulting erosion cut off the Danube from its wetland. The Gabčíkovo scheme provided a chance to recharge the wetland by diverting up to 10 per cent of the canal flow. The creation of a reservoir at Cunovo would replenish underground water reserves. There were also plans to link the waters of the wetland and the old Danube to enable fish to spawn. However, the Hungarians believed that damage would yet be caused in the future because the ground water level was too high and groundwater quality would deteriorate because of dirty water standing in the reservoir. All sides agreed that the Danube showed the knock-on effects of river engineering, with river regulation on one part pushing the problem to another part.

Europe

95-0069

### Characterization of river channel adjustments in the Thames basin, south-east England

P. W. DOWNS (Nottingham University)

*Regulated Rivers: Research & Management*, 1994, 9, No 3, 151-175

Data derived from geomorphological reconnaissance surveys and maps were analysed to characterize river channel adjustments in 4 catchments in the Thames basin. Logistic regression was used to generate multivariate equations relating 4 types of adjustment to catchment characteristics (rock type, gradient, land use and channel management). Geomorphological interpretations of these characterizations generally indicated the varying balance between large-scale natural controls and more local human influences in determining the types of adjustment. In the lowland environment studied, few channels could recover their sinuosity following channel straightening. There are 92 references. U.K.

95-0070

### Flooding and erosion hazards on the Ontario Great Lakes shoreline: a human ecological approach to planning and management.

P. L. LAWRENCE (Waterloo University, Ont.) and J. G. NIELSEN

*Journal of Environmental Planning and Management*, 1994, 37, No 3, 289-303

Variations in climate, geology, vegetation, land uses and human activities prevented generalizations on natural hazards. There was considerable variation in the intensity, frequency and magnitude of hazards among and within the Great Lakes system. The use of structures to control erosion and flooding along shorelines interfered with sediment transport and supply. Flooding was exacerbated by large-scale drainage programmes. Zoning and other land use controls to regulate development had generally been ineffective. A new response to hazards was needed which took into account their natural and human context. A study of resources, land uses and management approaches for the Saugeen Valley Conservation Authority used a broad land use and ecosystem approach which was applicable to developing a shoreline management plan. Canada

95-0071

### Changes in acidification of lochs in Galloway, south-western Scotland, 1979-1988: the MAGIC model used to evaluate the role of afforestation, calculate critical loads, and predict fish status.

R. F. WRIGHT (Norwegian Institute for Water Research, Oslo, Norway), B. J. COSBY, R. C. FERRIER, A. JENKINS, A. J. BULGER and R. HARRIMAN

*Journal of Hydrology*, 1994, 161, No 1/4, 257-285

Major changes in water chemistry in 50 lochs in the Galloway area of south-west Scotland during a 9-year period were evaluated. Acidic deposition in the area had decreased substantially in the period since 1980. Differences between data sets obtained in 1979 and 1988 provided a useful basis for the evaluation of acidification models, particularly MAGIC (Model for Acidification of Groundwater in Catchments). MAGIC successfully reproduced the major changes in water chemistry in the period. A fish response function coupled with MAGIC provided the basis for evaluation of fish status in the region. The study showed that afforestation could worsen the effects of acid deposition in the Galloway area. There are 39 references. U.K.

95-0072

### Physical limnology and water quality modelling of North American Great Lakes. Part I. Physical processes.

C. R. MURTHY (Environment Canada, Burlington, Ont.) and W. M. SCHERTZER

*Water Pollution Research Journal of Canada*, 1994, 29, No 2/3, 129-156

Physical limnological research relevant to large lake water quality issues conducted in the Great Lakes, particularly Ontario lake, since 1970 is reviewed. The climate and hydrology of the Great Lakes is described. Studies on large-scale circulation (winter and summer circulation) and coastal circulation are reviewed. Persistent boundary currents occur near the north and south shores. The occurrence of internal Kelvin wave propagation following major upwelling events has been observed. Turbulent diffusion characteristics, based on large-scale studies, are considered. There are 41 references. (see also following abstract). Canada

95-0073

### Physical limnology and water quality modelling of North American Great Lakes. Part II. Water quality modelling.

W. M. SCHERTZER (Environment Canada, Burlington, Ont.) and C. R. MURTHY

*Water Pollution Research Journal of Canada*, 1994, 29, No 2/3, 157-184

Examples where physical limnological processes play a dominant role in water quality and contaminant modelling in lake-wide, basin-wide and coastal areas of large lake systems are presented. Lake and coastal circulation models, thermocline models, and water quality (eutrophication and contaminant transport) models are reviewed. The effects of climate warming on water quality are considered. Further research in large lake systems is required to determine the impacts of modified weather conditions on physical and biochemical responses. There are 44 references. (see also preceding abstract). Canada

95-0074

**Hydrodynamics of lakes Ladoga and Onega.**D. V. BELITSKY (Institute for Lake Research, St. Petersburg),  
N. N. FILATOV and R. A. IBRAEV*Water Pollution Research Journal of Canada*, 1994, 29, No 2/4,  
365-383

Hydrodynamic studies and modelling simulations conducted in the largest European lakes, Ladoga lake and Onega lake, both in Russia, are reviewed. A three-dimensional primitive equation diagnostic model was used to calculate the currents in Ladoga lake above thermal bar and full stratification period. Time series analysis of currents and temperature in Ladoga lake are outlined. The physical experiment ONEGO in Onega lake was conducted to measure spatial and temporal variability and temperature fields in spring and summer. Large scale current and temperature variability was observed in both lakes with several energy peaks, reflecting the lake responses to atmospheric forcing. Wind induced upwelling and upwelling relaxation mechanisms are considered. **Russia**

95-0075

**Application of remote sensing in the visible spectrum for hydrodynamic studies in lakes.**

K. Y. KONDRAVYEV (St. Petersburg Research Centre for Ecological Safety) and D. V. POZDNYAKOV

*Water Pollution Research Journal of Canada*, 1994, 29, No 2/4,  
385-402

Large scale limnological applications of active lidar optical remote sensing techniques are described. Experiments using helicopter as a platform to study the 2-dimensional distributions of chlorophyll and dissolved organic matter concentrations in Onega lake and Seyan lake, Russia, are outlined. The lidar complex consists of an Nd:YAG laser, a collimation light source, transceiver optical system, receiving phototelescope, polychromator, a system of sensors and amplifiers, a TV, a film and analogue to digital converter, and an information computing system. The results of an airborne lidar study of hydrodynamic processes in the Samara water storage reservoir are described. There are 38 references. **Russia**

95-0076

**Water-supply operations during drought: continuous hedging rule.**

J. S. SHIH (Carnegie Mellon University, Pittsburgh, Pa.) and C. FAYELLE

*Journal of Water Resources Planning and Management*, 1994,  
120, No 5, 613-629

Policy rules were developed for the demand management operation of a single water supply only reservoir during drought to minimize total damages or economic disruption. A linear continuous hedging rule initiated rationing when the sum of actual storage plus anticipated inflow was less than a trigger volume and the criterion of minimizing maximal shortfall for a 36-month sequence of the worst recorded drought was used to compare parameter determination using 2 mathematical programming techniques. The polytope search procedure that combined simulation and optimization was efficient and relatively effective while the second method, an iterative mixed integer programming model, provided smaller maximal storage values at greater computational expense. A method of transforming continuous hedging rules into discrete hedging rules is presented. **U.S.A.**

95-0077

**Barrage developments in the Welsh region: the role of the National Rivers Authority in protecting the aquatic environment.**

I. H. JONES (NR, Llanelli)

*Journal of Institution of Water and Environmental Management*,  
1994, 8, No 4, 431-439

Experiences gained by the Welsh Region of the NRA in negotiating the Tawe, Cardiff bay and Usk barrages are presented. Environmental safeguards secured for the Tawe barrage and initial impact assessments are presented and their incorporation into the Cardiff bay and Usk projects are presented. Safeguards achieved in the areas of water and aesthetic quality, fisheries, conservation and flooding are summarized. **U.K.**

95-0078

**The 1993 oil spill off Tampa bay, a scenario for burning?**

R. P. LEBLOND (U.S. Minerals Management Service, Herndon, Va.), J. A. GALLIE, J. ITINNYSON and K. H. MCGRAHAN

*Spill Science & Technology Bulletin*, 1994, 1, No 1, 5-9

The applicability of burning for the management of the Tampa bay oil spill is considered. Although the type of oil spill here was not suitable for burning the movement of the oil was studied, and the effects of a fire were modelled using the Large Eddy Simulation smoke plume model. The studies showed that burning the oil would cause less damage to the environment and human health than the beached oil did. In a spill there would usually be a small window of opportunity for burning to be carried out, when the spill was in a suitable position and before it had spread too thinly or become emulsified. Spill responders need to be able to react quickly to take advantage of this time window if burning is to be of use. **U.S.A.**

95-0079

**Air cushioned vehicles: efficient alternative transportation for spill response.**

M. W. MCCARTHY (OHM Corporation, Seattle, Wash.) and J. McGRATH

*Spill Science & Technology Bulletin*, 1994, 1, No 1, 79-84

Once oil moves into shallow water the management becomes labour intensive and efficient transportation of people and equipment is essential. The requirements for speed and cargo capacity can be met by the use of air cushioned vehicles (ACV). Case studies are presented to illustrate the advantages of ACV in responding to spills. **U.S.A.**

95-0080

**A study on the effects of oil fires on fire booms employed during the in situ burning of oil.**

R. LAZES (Oil Stop, Inc., Harvey, La.)

*Spill Science & Technology Bulletin*, 1994, 1, No 1, 85-87

Test oil burns were carried out in tanks, using an inflatable fire boom to evaluate its ability to withstand high temperatures. Fire temperatures reached 1102°C and the boom surface reached 950/900°C. Ceramic materials withstood the heat but lost tensile strength and became brittle. They should not be subjected to tensional loads during burns because they might fail. Waves and salt water increased the brittleness of the outer layers. The addition of underwater tubes to allow heat transfer between the inside of the boom and the water reduced the temperature inside the boom by 20 per cent, and reduced heat damage to the external fabric. **U.S.A.**



## WATER RESOURCES AND SUPPLIES

95-0081

### **Causes for the lowering of groundwater levels south of Tilburg.**

D. H. FLIEGMAN (NV Tilburgsche Waterleiding Maatschappij), *H2O* 1994, 27, No 19, 560-563 (in Dutch, English summary, p.559).

Since 1988, significant lowering had been observed in wells of the Tilburg (Netherlands) water undertaking, to levels below those reached in the drought years of 1975-76. It was not possible to attribute this to another drought, or to increased abstraction by the municipal undertaking or industrialists. Indeed, the recently promulgated national policy requiring undertakings to take a greater proportion of their supplies from surface water, in order to conserve groundwaters as wetland water sources, should have produced the opposite effect to that found. The causes are believed to be expansion of the irrigated acreage, combined with a regulation on river levels designed to facilitate drainage from irrigated lands. The true volume of groundwater abstracted per ha of irrigated land is also believed to be considerably in excess of that declared in official statistics. (English translation 165 pounds sterling, valid for 1995).

**Netherlands**

95-0082

### **Geographic information systems: a tool for strategic ground water quality management**

L. W. CANTER (Oklahoma University, Norman), A. K. M. M. CHOWDHURY, and B. E. VILUX

*Journal of Environmental Planning and Management*, 1994, 37, No 3, 251-266

Integrated groundwater quality management programmes included elements needing geographically related information. A geographic information system (GIS) is a potentially useful tool in wellhead protection and groundwater management studies. Case studies of the use of GIS in the management of wellhead protection areas are reviewed in terms of software used, data source, variables and specific applications. The most common application was for identification of potential contaminant sources within the delineated zone. Other major applications included: the use of maps for intertown management issues; reduction and management of future land uses; information provision to local governments and agencies; and map production in different formats. GIS technology provided a unique opportunity for analysing and visualizing spatial data. **U.S.A.**

95-0083

### **Three-dimensional steady groundwater flow and advective transport by integral transforms**

J. H. HELLANGÅSEKARI (Colorado University, Boulder), J. H. BRANNON, and B. AMADI

*Journal of Hydrology*, 1994, 161, No 1-4, 109-131

A quasi-analytical technique based on integral transforms was used to solve the governing equations for steady groundwater flow and advective transport in aquifers. The technique did not require any spatial discretization of the solution domain. It gave rise to a continuous and differentiable solution to the groundwater flow equation. This made it possible to obtain a continuous velocity field in three-dimensional physical domains with no spatial discretization. The advection component of the transport equation was solved using this velocity field together with a method of characteristics particle tracking scheme. A transport model based on this technique was analysed for its effectiveness as a modelling tool. **U.S.A.**

95-0084

### **A field test of the modified SP log interpretation method for estimating groundwater salinity.**

R. NATIV (Hebrew University of Jerusalem, Rehovot), and H. FLIEGMAN

*Journal of Hydrology*, 1994, 161, No 1/4, 133-144

A study was undertaken to improve the technique currently used to calculate salinity in saline water bodies with the help of spontaneous potential (SP) logs. Smits model for the interpretation of groundwater conductivity, which could be correlated with salinity, was modified for this purpose. The modified approach took account of the influence of the clay mineral content and its electrochemical properties on the electrochemical potential. Smits model was tested in 4 deep boreholes in Israel. Sample cores were analysed for minerals and for cation exchange capacity, porosity and bulk density. In the conditions studied, the modified Smits model provided no advantage over the conventional method. **Israel**

95-0085

### **Power from groundwater**

W. F. BARDSEY (Waikato University, Hamilton)

*Journal of Hydrology*, 1994, 162, No 1/2, 191-196

Power generation from groundwater involved pumping water from bores to a power station located lower than bore water level. An example is presented to illustrate the use of a simple analytical model for first order estimation of power potential in situations where the Dupuit flow model was applicable. Groundwater power schemes could be particularly useful for isolated islands lacking streams suitable for hydropower development where the power station discharge would also provide a reliable fresh water supply. Advantages of small scale groundwater power schemes over stream based systems included reliability during drought or freezing conditions, avoidance of spillage losses and variable output. Large groundwater schemes could be expensive but might be feasible in some high elevation regions where the aquifer would act as the storage reservoir, eliminating the need for storage dams. Evaluation of potential groundwater power sites would require more hydrological information than river based systems, the application of numerical groundwater models on a case by case basis, and pumping tests. **New Zealand**

95-0086

### **Modelling 3D ground-water flow by modified finite-element method**

F. X. YU (Louisiana Transport Research Centre, Baton Rouge) and V. P. SINGH

*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 5, 892-909

The finite element method for modelling 3 dimensional steady and unsteady groundwater flow was improved by combining the Galerkin method with the collocation method to handle the time derivatives and by using finite integration to solve the resulting systems of ordinary differential equations. The commonly used finite differences solution scheme provided an exact solution only when the weighting factor equalled 0.5. A nearly exact solution could be obtained by using the mixed or the lumped formulation with a proper time step. The proposed formulation which was applicable to most practical initial and boundary conditions, aquifer compositions and sources/sinks was coded in FORTRAN and verified by comparing the results obtained for 4 flow case studies with those of existing analytical and numerical solutions. **U.S.A.**

95-0087

**Comparison of intraparticle sorption and desorption rates for a halogenated alkene in a sandy aquifer material.**

J. C. HARMON (California University, Los Angeles) and P. A. ROBERTS

*Environmental Science & Technology*, 1994, 28, No 9, 1650-1660.  
The rate of desorption of a halogenated alkene from a water saturated aquifer material was investigated to test the hypothesis that the desorption rate was equal to the rate of sorption in the system. Ways of determining desorption rate parameters for use in aquifer remediation models were also examined. A batch desorption methodology using intermittent purging was developed. The dynamics of the observed desorption behaviour were simulated using a batch model incorporating radial pore diffusion with internal retardation. The model underestimated desorption rates at early times and overestimated rates at later times. There are 27 references. U.S.A.

95-0088

**The Yarkon-Taninim groundwater basin, Israel hydrogeology: case study and critical review.**

C. WEINBERGER (Hydrological Service of Israel, Jerusalem), I. KOSINHAU, A. BEN-ZVI and D. G. ZILHOUN

*Journal of Hydrology*, 1994, 161, No 1-4, 227-255.  
A long-existing conceptual hydrogeological model of the Yarkon-Taninim groundwater basin in Israel is critically examined. The basin comprises the western part of the Judea Group aquifer. The principal hydrogeological conventions accepted hitherto are considered, puzzling and contradictory phenomena described and questionable interpretations examined. The existing and accepted model of the basin can only be regarded as depicting general features and trends at a regional scale. Although the study related to a specific groundwater basin, the study and general approach adopted were possibly relevant to other water resources management situations. There are 56 references. Israel.

95-0089

**Delineation of recharge areas for selected wells in the St. Peter-Prairie du Chien aquifer Rochester, Minnesota.**

N. DEHN and J. E. ALMENDINGER

*U.S. Government Printing Office, Washington, D.C., Water Supply Paper No 2197*, 1993, 39pp.  
A report is presented of various methods for estimating the recharge areas for high capacity abstraction boreholes producing water for the city of Rochester in south-western Minnesota. One borehole was situated in an unconfined aquifer close to and in direct connection with a watercourse, and the other was located around 0.6 km from a stream in a confined region of the karstic aquifer. For groundwater travel times were estimated by various techniques, and for each of the wells the zone of transport areas obtained from the several analytical models were in good agreement. The Theis drawdown method however gave results which compared less favourably with other methods. Hydrogeologic mapping and numerical modelling were used to delineate zones of contribution defined as embracing all parts of a groundwater flow system which could contribute to a well. Differences in the computed areas of recharge obtained by alternative methods were attributed to their relative capabilities for representing changing conditions, including aquifer characteristics and discharges from nearby pumped wells. U.S.A.

95-0090

**Rehabilitation of hand-dug wells and springs.**

E. N. NYANCHAGA (Nairobi University)

*Aquar*, 1994, 43, No 5, 233-237

A survey of hand-dug wells within a 24 km<sup>2</sup> rural area of Kenya showed 97 per cent to be bacteriologically unsatisfactory by WHO guidelines. Most could be rehabilitated by partial or full well lining and the installation of a hand pump. Conversion to a tube well was recommended for those whose yields were unreliable in the dry season. Protected springs could be rehabilitated by cleaning the backfill, refilling with boulders, repairing the headwall, improving drainage and covering the backfill with polythene. The costs and techniques were within the capabilities of local people. Recommendations for government action to support this work are made. Kenya.

95-0091

**Recharge wells: removal of filter cake by scraping the bore-hole wall.**

T. N. OLSHOORN (Gemeentewaterleidingen, Amsterdam) and S. van HARTINGEN

*H2O*, 1994, 27, No 21, 636-639 (in Dutch-English summary, p. 639).

The cleaning of the bore-hole wall of recharge wells is described. A method was developed to scrape the wall. It was implemented in 1993 during the construction of 4 recharge wells. The scraping was extremely effective without detriment to the overall efficiency of the well drilling and construction. The development was a joint initiative of Amsterdam Water Supply and De Ruiters BV. (English translation 150 pounds sterling, valid for 1995). Netherlands.

95-0092

**Optimal operation of ground-water supply distribution systems.**

S. PEZESHK (Memphis State University, Tenn.) and J. HILLWEIG and K. F. OLIVER

*Journal of Water Resources Planning and Management*, 1994, 120, No 5, 573-586.

A nonlinear optimization model for minimizing the pumping cost of a complex groundwater supply distribution system with a pump and station reservoir, developed a local cost pumping algorithm for each well field and an optimal pumping schedule for the principal distribution system. Individual well losses, pump efficiencies and hydraulic losses in the pipe network were considered and transient drawdown was included in a well field model. The simulation model was calibrated for the system involved and the optimization procedure then provided the combination of pumps that minimized energy requirements for a specified demand. Two example problems illustrate application of the proposed method. U.S.A.

95-0093

**Evaluation of flow leakage through abandoned wells and boreholes.**

C. B. AYDIN (Bozok University, Istanbul)

*Water Resources Research*, 1994, 30, No 9, 2565-2578

The possibility that leakage through abandoned wells and inadequately boreholes could create vertical communication between otherwise isolated water-bearing zones and give rise to aquifer contamination was examined. The transient flow rate through such artificial conduits was evaluated analytically. Hydraulic head distributions were obtained for the situations where artificial gradients were created by an injection well operating in one of the aquifers and

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where natural hydraulic head differences were present between 2 confined aquifers. A case study involving contamination leakage caused by the operation of deep waste injection wells is considered (Turkey).

**95-0094**

### **Calculating the effects of recharge using treated sewage on the upper aquifer of the Berlin-Buch irrigation fields.**

G. NUTZMANN (Institut für Gewässerökologie und Binnenfischerei im Forschungsverbund Berlin e.V.), H. SCHOLZ, G. GINZEL and H. HANDKE  
*GWf-Wasser/Abwasser* 1994, 135, No 9, 523-528 (in German, English summary).

The discontinuation of land application as a method of treatment for sewage from the city of Berlin after a period of around 100 years has resulted in a pronounced change in the water balance and a fall in the water table below the former irrigation fields. This has manifested itself in negative effects on the local woodland and wetlands areas together with the mobilization of various substances contained within the soil matrix and the unsaturated zone above the new water table. To counteract some of these effects a recharge scheme is proposed using treated sewage effluent as a basis for achieving a better ecological balance. As a prelude to such a scheme extensive studies were performed on the nature and composition of the underlying strata and on the groundwater flow patterns, assisted by tracer experiments in the groundwater body and flow measurements in the drainage system. A mathematical model capable of simulating the natural flow pattern together with the effect of artificial inputs was also developed and calibrated relative to the existing data. The results of these studies were used to control the irrigation rates from a prototype system and as a basis for the design of a more extensive scheme with inputs of up to 2000 m<sup>3</sup> per d. (English translation 170 pounds sterling, valid for 1995). **Germany**

**95-0095**

### **Groundwater clean-up and the art of the possible.**

*ENDS Report* 1994, No 235, 21-23.

The U.K. lacked a clear groundwater contamination policy whereas in the U.S.A. it had been a national priority since the late 1970s. Usually the U.S. EPA required cleanup to health based drinking water standards. However, there was a growing concern that this was often impossible. The National Research Council considered that pump and treat methods, the most common remediation system, were inherently inefficient but the enhanced versions of the method could improve contaminant removal. A review of cleanup sites showed that very few had been successfully remediated. Particular problems were caused by non-aqueous phase liquids. An assessment of several cleanup technologies showed that no known technology could ensure the achievement of health based cleanup goals at complex sites. **U.S.A.**

**95-0096**

### **Better prediction of groundwater cleanup operations by description of tailing**

C. van den BRINK (IWACO BV) and P. M. A. van BERGEN  
*H2O* 1994, 27, No 21, 620-623 (in Dutch, English summary, p.619).

Complete groundwater clean up by pumping usually began with swift reductions in contaminant concentrations then little further reduction. Furthermore, concentrations often rose when pumping ceased. A program was developed to describe this tailing in terms of the behaviour of solutes along a path line and to predict the rise in

concentration after pumping. Quick and slow equilibrium processes occurring under such conditions were taken into account. The program was a useful tool in understanding the impact of some important processes on the course of a clean up operation. (English translation 135 pounds sterling, valid for 1995). **Netherlands**

**95-0097**

### **Still flowing waters.**

K. HAYWARD

*Water & Environment Management* 1994, No 19, 14-15.

A suitable for use approach to the cleanup of contaminated land was taken by a Government consultation paper. Such an approach did not automatically consider the water environment, yet groundwater could be affected by ongoing leaching or by leaching during or as a result of cleanup. The potential impact on groundwater ought to be considered as part of a planning application, but there were problems about assessing the threat of contamination, in particular the lack of a standard leachability test. **U.K.**

**95-0098**

### **The Swiss concept of groundwater protection.**

P. MICHEL (BUWA1, Bern) and D. HARTMANN

*Water Supply* 1994, 12, No 1/2, SS 15-1, SS 15-4.

Groundwater was threatened by the excessive nitrogen and pesticides used in intensive agriculture, leakage from drainage systems and accidental pollution. A strategy for protection would involve defining groundwater categories and the treatment appropriate for them. Thus, phreatic groundwater in alluvial formations should require no treatment before use while that in rock formations should need only simple treatment. Groundwater not considered suitable for drinking should not be allowed to pollute higher quality water. All drinking water catchment areas had to be clearly defined and activities within them controlled to prevent pollution. This necessitated systematic policing and monitoring. **Switzerland**

**95-0099**

### **Using water wisely - the public relations aspect.**

G. D. J. ATKINSON (Umgeni Water, Pietermaritzburg, South Africa)

*Water Supply* 1994, 12, No 1/2, IR 4-1, IR 4-7.

An international overview on the public relations aspect of using water wisely is provided as an introduction to national reports. There was a general trend throughout the world, even in developed countries, to make efficient use of water which could be both scarce and costly. Methods of imparting the message of wise water use varied widely, the media, educational literature, visits to water treatment installations, and information with water bills were common methods. Emphases were different between developed and developing countries. Results varied but were usually positive and sometimes improved the public's perception of the water utilities. A common theme was to focus efforts on young people so that the next generation would conserve water. Examples are drawn from national reports. **International**

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See also Abstracts 95-0005, 95-0007, 95-0008, 95-0012, 95-0024, 95-0038, 95-0050, 95-0059, 95-0062, 95-0072, 95-0073, 95-0241, 95-0243, 95-0447, 95-0448

## 95-0100

**Thermal structure of lakes varying in size and water clarity**  
 A. MAZUMDER (Montreal University, P.Q.) and W. D. JAYLOR

*Limnology and Oceanography* 1994, 39, No 4, 968-976  
 Two principal variables relating to epilimnion depth are lake size which influences wind mixing effects and water clarity which affects the thermal regime. Previous data gathered during surveys of numerous lakes were used to attempt the isolation of the relative importance of these 2 variables by examining lakes that have changed in clarity from year to year, lakes of comparable size and by separating lakes into subsets with a limited range in size or Secchi depth. Results indicate that both water clarity and lake size have important effects on epilimnion depth. The absolute effect of water clarity is approximately constant in both small and large lakes though its relative importance is much less in large lakes. There are 32 references. (Canada)

## 95-0101\*

**Time series modelling of water resources and environmental systems**

K. W. HIPEL (Waterloo University, Ont.) and A. E. McLEOD  
*Ecological Science B.V., Amsterdam, Developments in Water Science* 1994, No 45, 1013pp

The principal purpose of this book is to present the art and craft of time series (the development and application of statistics in the environmental sciences) for modelling water resources and environmental systems. Specific statistical models and general methodology are described. Virtually all of the tools presented are highly computerized theoretically and possess algorithms that allow them to be applied in practice. The book comprises 24 chapters in 10 parts, dealing with linear non-seasonal models, model construction, forecasting and simulation, long memory modelling, seasonal models, multiple input/single output models, intervention analysis, multiple input/multiple output models, and handling messy environmental data. Part I gives the scope of the book and some statistical definitions and notation in time series modelling. Most of the chapters contain descriptions of techniques, representative applications, appendices, algorithms and references. There is a total of 1334 references. (Canada)

## 95-0102

**QA12E simulations of pulse loads.**

R. WALTON (WEST Consultants Inc., Seattle, Wash.) and M. WEBB

*Journal of Environmental Engineering* 1994, 120, No 5, 1017-1031

The river water quality model QA12E was used to examine the environmental impacts of combined sewer overflows to the Charles river system in Boston, Mass. The form and impact of numerical dispersion in this model are considered. An alternative scheme is proposed to allow simulations of pulse loads. The existing model was in implicit backward difference scheme which produced positive numerical dispersion for all conditions. This limitation was reduced

by replacing the existing scheme with an explicit backward difference scheme allowing accurate simulation of pulse loads within certain simplifying conditions and time step controls. (U.S.A.)

## 95-0103

**A general structural equation model for river water quality data.**

S. ZHU (Kansas University, Lawrence) and Y. S. YU  
*Journal of Hydrology* 1994, 162, No 1-2, 197-209

Major unobserved factors that affected observed water quality could be investigated by establishing linear structural equations to represent the relationship between all observed and unobserved (latent) variables including model and measurement errors. A general structural equation model with latent variables was based on a sample correlation matrix for 14 river water quality constituents measured at a fixed station. Model identification conditions were considered for 3 traditional factor models and 2 general structural equation models, and model parameters were estimated by minimizing the differences between model predicted and sample covariances. Model evaluation was based on the overall fit measure and the principle of parsimony and model interpretation of latent factors was enhanced by decomposing the effects of 1 variable on another into direct and indirect effects. The estimators for structural equation models were less restrictive than the routine distributional assumptions made for analysis of variance or regression analysis. (U.S.A.)

## 95-0104

**Mixed layer models and their application to water quality problems**

M. J. MCCORMICK (National Oceanic and Atmospheric Administration, Ann Arbor, Mich.)

*Water Pollution Research Journal of Canada* 1994, 29, No 2/3, 257-267

Four one-dimensional models for characterizing surface mixed layer processes and the thermal structure of a water column are examined. They are the Mellor and Yamada (1982) model (MY21/2 model), the McCormick and Siver (1981) eddy diffusion model (K), the Garbed (1972) integral mixed layer model (RWG), and the Thompson (1976) model (RL). Three of the models (K, RL and RWG) were used in Erie lake simulations and the MY21/2 and RWG models were used in simulations of North Pacific data. The RWG, RL and MY21/2 models were highly correlated to each other in their response to wind deepening in the mixed layer. The K model failed to trace storm induced deepening of the surface mixed layer. A general water quality model was derived from mass conservation principles to demonstrate how mixed layer models can be used to address water quality issues. (U.S.A.)

## 95-0105

**Responses of plankton, turbidity, and macrophytes to biomanipulation in a shallow prairie lake.**

M. A. HANSON (North Dakota State University, Fargo) and M. G. BUTLER

*Canadian Journal of Fisheries and Aquatic Sciences* 1994, 51, No 5, 1180-1188

Low densities of *Bosmina* and *Chydorus* were replaced in the early spring/early summer by high densities of *Daphnia galeata* and *Daphnia pulex* in the first year after fish kill in a large, shallow prairie lake in Minnesota. Chlorophyll *a* concentrations and edible phytoplankton were reduced, water transparency increased and submerged macrophytes expanded during May/June when daphnid abundance was greatest. Orthophosphate and ammonia were detected

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able during clear water phases. The increased water transparency in subsequent years was related to decreased sediment resuspension and lower algal biomass due to the expansion of submerged macrophytes. Macrophytes prolonged the early effects of fish kill and imposed subsequent constraints on phytoplankton biomass and turbidity. These results support the contention that for eutrophic, shallow lake, where macrophytes are tolerable or desirable, food web manipulation is a very effective lake management tool. There are 55 references. U.S.A.

95-0106

### Temporal and spatial environmental variability in the upper Rhone river and its floodplain.

B. CHIFFOL (Université Lyon-Villeurbanne), M. J. DOLL, OLIVIER G. BORNETIE and G. PAUTOU. *Freshwater Biology*, 1994, 31, No 3, 311-325.

A framework of spatial and temporal environmental variability for a typology of the upper Rhone river and its alluvial flood plain based on about 13 years of data collection and analysis is presented. Eight physico-chemical variables were available and could be considered for 22 habitat types: 17 superficial and 5 interstitial, in 2 areas (Clons and Bregnot, Cordons). The data sets used were processed by a fuzzy coding method using, for each variable, the frequency distribution of all the measurements and monthly means over an annual scale. The 2 tables produced that gave an expression of total variability and an evaluation of the temporal variability, were analysed by correspondence analysis giving the positions of the 22 habitat types on the spatial and temporal variability axes. There are 43 references.

France

95-0107

### Theoretical habitat templets, species traits, and species richness: a synthesis of long-term ecological research on the upper Rhone river in the context of concurrently developed ecological theory.

A. H. RESHI (California University, Berkeley), A. G. HILDREW, B. STAELZNER and C. R. TOWNSEND. *Freshwater Biology*, 1994, 31, No 3, 539-554.

A synthesis of information obtained from 13 taxonomic groups of plants and animals in the upper Rhone river showed that species traits describing reproductive characteristics, food and size had the closest relationships with each other in the various correspondence analyses performed. There were 2 major gradients in habitat utilization: a vertical gradient from interstitial to superficial habitats and a transverse gradient from the principal channel to oxbow lakes, temporary waters, and terrestrialized habitats. In most groups there was a statistically significant relationship between structure of the species traits and habitat utilization. Species traits did not conform to predictions of the river habitat templet. The patch dynamics concept was supported by observations in 2 of the 13 groups examined and only partially when all 548 taxa were examined together. The implications of this project for future research on habitat templet theories and on the applicability of using the information obtained to develop ecologically based river management options are discussed. There are 31 references. U.S.A.

95-0108

### Renaturalization of watercourses: principles, problems, experience.

W. KONOLD (Universität Hohenheim, Stuttgart). *GWF-Wasser/Abwasser*, 1994, 135, No 9, 516-518 and 520-522 (in German, English summary).

The widespread attempts at flow regulation and channel improvement measures undertaken during recent years in the interests of land drainage and flood prevention have frequently been performed with complete disregard of the surrounding environment. As a result the diversity of plant and animal species has declined and the visual appearance of the affected areas has deteriorated. The recent increase in ecological awareness has prompted a reversal of this trend, and the present article presents a range of typological approaches to the classification and restoration of the aquatic environment and its immediate surroundings (flood meadows and adjoining land). The definition of the natural or original state of a given area must be attempted as a basis for the implementation of a renaturalization project, in order to ensure that the correct flora and fauna are reintroduced, and that habitats which favour their growth and development are available. The choice of materials (eg natural stone and bed materials), the choice of plants and morphology of the channel all have important influences on the outcome of such schemes. The preparation of an inventory of natural species and features peculiar to the locality is advocated as a starting point. Some of the conflicts of opinion which must be resolved, such as those between pragmatists and purists, are also discussed. (English translation, 240 pounds sterling, valid for 1995). Germany.

95-0109

### Fish habitat and fish populations in a southern Appalachian watershed before and after Hurricane Hugo.

C. A. DOLLOFF (Virginia Polytechnic Institute and State University, Blacksburg), P. A. FLEBBE and M. D. OWEN. *Transactions of the American Fisheries Society*, 1994, 123, No 4, 668-678.

Stream habitat and species composition of fish in Basin Cove watershed in the Appalachian mountains were estimated before and 11 months after Hurricane Hugo in 1989. There was no change in the total area of each habitat type but the total number of habitat units decreased by 30 per cent and the average size and maximal depth of habitat units increased by 16 and 18 per cent, respectively. Large gravel and sand were the dominant streambed substrates before Hugo. After the hurricane, larger or scoured substrates dominated. The species composition and distribution of fish were similar before and after Hugo. Eleven species were found both before and after the hurricane. Densities increased in riffles for darters (*Etheostoma* spp.) and increased in pools for blacknose dace (*Rhinichthys atratulus*). Rainbow trout (*Oncorhynchus mykiss*) densities were unaffected. The results suggested that the effects of large disturbances on fish habitat and populations depend on the predisturbance conditions of instream and riparian habitats, the timing of events, and on the life histories of the affected species. There are 39 references. U.S.A.

95-0110

**Determination of ecologically acceptable flows in rivers with seasonal changes in the density of macrophyte.**

J. HEARN (Natal University, Pietermaritzburg) and P. ARMITAGE

*Regulated Rivers: Research & Management* 1994, 9, No 3, 177-184

The physical habitat simulation software package PHABSIM was examined in relation to rivers with seasonal changes in macrophyte season, using a hypothetical test channel with known hydraulic properties. The results were compared with artificially generated field data. The study confirmed that the effects of in-stream macrophyte growth could significantly distort PHABSIM results. The predicted weighted usable area could differ from field data by as much as 34 per cent, depending on the season used for the principal definition of the water surface profile module of PHABSIM. An extension is proposed to improve the accuracy of PHABSIM output for the conditions considered. **South Africa**

95-0111

**Periphyton reactions to different light and nutrient levels and the response of bacteria to these manipulations**

J. A. HEPINSTALL (Maine University, Orono) and R. L.

TILFER

*Limnology and Oceanography* 1994, 39, No 2, 163-175

Effects of the periphyton biomass, and bacterial densities in open and shaded sections of a second order stream showed that algal density was reduced by 40 per cent or more in naturally and artificially shaded sections suggesting that light was the principal limiting factor in shaded sections. Using clay diffusion pots, limitation by nitrogen and phosphorus was only seen in October. A positive correlation between algal abundance and bacterial abundance. Bacteria were sometimes nitrogen and/or phosphorus limited but only when algal biomass was very low, indicating that the epiphytic mat is developed and thick. Bacteria may be taking energy and nutrients from the algae. There are 50 references. **USA**

95-0112

**Urea decomposition associated with the activity of microorganisms in surface waters of the North Han river, Korea**

J. MIYAMURA (Osaka Kyoriku University, Japan), K. S. CHO and S. U. HONG

*Aquatic Microbiology* 1994, 33, No 2, 235-242

Urea decomposition rates of 0.1-1.1 and 0.1-2.8  $\mu\text{mol per m}^3 \text{ h}$  were recorded in the light and dark, respectively, in the surface waters of North Han river. In polluted eutrophic waters, decomposition rates were much higher and there was no difference between rates in light and dark. Only negligible levels in the phase of carbon incorporation were observed in the upper reaches of the river, but high ratios were obtained at polluted eutrophic sites. Urea decomposition rates in unpolluted water were proportionate to the standing crop of phytoplankton, while in polluted eutrophic waters urea seemed to decompose under the competitive action of bacteria and phytoplankton. There are 33 references. **Korea**

95-0113

**Zooplankton distribution in the Guarau river estuary (south-eastern Brazil)**

R. M. LOPES (Universidade Federal do Paraná, Curitiba)

*Estuarine, Coastal and Shelf Science* 1994, 39, No 3, 287-302

Zooplankton dynamics in the Guarau river estuary of south eastern Brazil were investigated during a period of 1 year. Multivariate analysis showed that the spatial segregation was conditioned principally by the longitudinal salinity gradient. In the upper estuary a large indigenous population of the estuarine copepod *Pseudodiaptomus riibardi* was dominant, while in the middle estuary the estuarine marine copepods *Acartia* (*acartia*) and *Oithona* (*hebes*), along with meroplanktonic organisms were also present. In the outer estuary there were high standing stocks of marine curvilinear species such as *Paracalanus crassirostris* and *Pseudodiaptomus acutus*, maintained by recruitment from coastal waters. There are 47 references. **Brazil**

95-0114

**Possible limiting factors in the occurrence of *Daphnia* species in the Berge Platen**

M. TIMBELK (Hoogheemraadschap van Schieland)

*H2O* 1994, 27, No 30, 602-605, in Dutch, English summary, p. 59-61

An explanation was sought for widely differing densities of zooplankton in 2 eutrophic ponds within Rotterdam. Both were used by anglers, who regularly netted many zooplankton in one, but not in the other. Both contained similar species. Attention was directed to the density of *Daphnia*, data being collected for about 1 year, from mid 1990 to mid 1991, one pond, that which yielded the zooplankton contained far more specimens than the other. Zooplankton numbers may to an extent have been kept down by predators including fish, but the more likely cause of the difference was the greater blue algal population, every year in one pond, of highest magnitude, 150 pounds, steadily, and for 1995. **Netherlands**

95-0115

**Algae enhancing musty odour production by actinomycetes in lake Kasumigaura**

N. SUGIURA (Ibaraki Prefectural Water Works Water Quality

Examination Laboratory, Tsukuba) and Y. INAMORI, Y.

HOSAKA, R. SUDO and G. TAKAHASHI

*Hydrobiologia* 1994, 288, No 1-2, 64

The effects of blue-green algae *Microcystis aeruginosa* and *Anabaena spiroules* and the diatom *Synedra acus* on the musty odour production by actinomycetes in sediment isolated from Kasumigaura lake, Japan, were studied. The actinomycetes effectively utilized the cyanobacteria and diatoms as carbon source and proliferated, causing an intense musty odour. *Streptomyces* spp. released 1,1-dimethyl-3-hydroxy-2-isobutanol in shaken sediment cultures. The occurrence of a musty odour in the lake was caused by high populations of algae and actinomycetes, and aerobic conditions in the sediment. **Japan**

95-0116

**Nutrient characteristics of well-mixed coastal waters off Perth, Western Australia**

R. F. JOHANNES (CSIRO Marine Laboratories, Marmion

WA), A. F. PEARCE, W. J. WIEBE, C. J. CROSS and D. W. RIMMER, D. E. SMITH and C. MANNING

*Estuarine, Coastal and Shelf Science* 1994, 39, No 3, 273-285

The dissolved nutrient regime of coastal waters off Perth, Western Australia, was investigated during a 4 year period. Seasonal cycles

## WATER QUALITY

and horizontal distributions of temperature, salinity and dissolved nutrients were examined. Although nutrients were present at low concentrations in the coastal waters, they supported highly productive benthic macrophyte communities. The coastal waters were thoroughly mixed and characterized by phosphate maxima in summer and silicate and nitrate maxima in winter. Nutrient concentrations were in the lower part of the range reported for temperate coastal waters elsewhere. Nitrate concentrations above sea grass and kelp dominated communities were controlled by benthic metabolism. There are 36 references. **Australia**

95-0117

### Subtidal volume fluxes, nutrient inputs and the brown tide - an alternate hypothesis

S. W. NIXON (Rhode Island University, Narragansett, S. I.), GRANGER, D. I., TAYLOR, P. W., JOHNSON, and B. A. BUCKLEY

*Estuarine, Coastal and Shelf Science*, 1994, **39**, No 3, 303-312. Factors influencing the occurrence of the intense brown tide of *Aureococcus anophagefferens* in Great South bay and other embayments on Long Island, New York, and in other adjacent systems during the spring and summer of 1985 are considered. A hypothesis consistent with the physical observations which led other researchers to the view that an increase in the retention of inorganic nutrients from land produced the brown tide, but more compatible with the nutrient budget of Great South bay, is proposed. This suggested that the blooms were associated with low inputs of inorganic nutrients. Evidence from field surveys and mesocosm experiments indicating that the growth of *Aureococcus* was favoured by oligotrophic conditions is reviewed. **U.S.A.**

95-0118

### The Ethiopian rift valley lakes - chemical characteristics of a salinity-alkalinity series

E. KEBEDE (Uppsala University, Sweden), Z. G. MARIAM, and E. ALH GREN

*Hydrobiologia*, 1994, **288**, No 1, 1-11. The chemical composition of 10 Ethiopian rift valley lakes (Metahara, Koka, Zway, Engeno, Abijata, Shalla, Chito, Awassa, Abaya, Chamo) was studied during March-May 1991. Electrical conductivity was 286-49,100  $\mu\text{S cm}^{-1}$ . Bicarbonate, carbonate, and sodium were the dominant ions in all the lakes. Potassium, chloride, and sulphate increased, and calcium and magnesium decreased, with increasing salinity and alkalinity. A comparison of the data with previous data showed that there was a ten-fold dilution of total ionic concentration during 30 years in Metahara Lake, and a three-fold increase during 65 years in Abijata Lake. Concentrations of soluble silica were generally high (2-22 mg per litre) but silica concentrations had declined from 28 mg per litre in 1964 to less than 1 mg per litre in 1991. There was no simple relationship between chlorophyll *a* and total phosphorus and dissolved inorganic nitrogen in the lakes. Zway, Awassa and Chamo lakes were phosphorus limited. There are 32 references. **Ethiopia**

95-0119

### Seasonal variability and biogeochemistry of phosphorus in the Scheldt estuary, south-west Netherlands

E. L. G. ZWOLSMAN (Delft Hydraulics)

*Estuarine, Coastal and Shelf Science*, 1994, **39**, No 3, 227-248. The geochemistry of dissolved and particulate phosphorus in the highly polluted Scheldt estuary, south-west Netherlands, was investigated during 8 cruises in 1987-1988. Plots of concentration versus

salinity for all seasons showed the effects of geochemical and biological processes on the behaviour of phosphate. The speciation of particulate phosphorus was investigated along the entire salinity gradient to gain additional insight into such processes as adsorption, desorption and biological uptake. The complex behaviour of phosphorus in the estuary was studied in relation to the implementation of nutrient reduction policies in the estuary. There are 77 references. **Netherlands**

95-0120

### Biogeochemical control of phosphorus cycling and primary production in lake Michigan

A. S. BROOKS (Wisconsin University, Milwaukee) and D. N. EDGINGTON

*Limnology and Oceanography*, 1994, **39**, No 4, 961-968. During a 3 year period chemical, temperature and chlorophyll *a* profiles were measured for a water column at a station in Michigan lake. There was a 27  $\mu\text{M}$  per  $\text{m}^2$  phosphorus increase in total phosphorus each spring when the lake was completely mixed, a value which was an order of magnitude greater than the annual phosphorus import to the lake. Increases in total phosphorus, chlorophyll *a* and organic nitrogen and reductions in soluble silicon and nitrate were in phase, while the concentration of soluble reactive phosphate remained fairly constant. The soluble reactive phosphate must be maintained by releases from the sediment to retain a mass balance. The duration of mixing and solar irradiation determined both the magnitude of the spring bloom and the phosphorus demand that had to be supplied by the flux of phosphorus to the overlying water column from the sediments. **U.S.A.**

95-0121

### Phosphorus dynamics in riverine lakes

B. C. KENNEY (Environment Canada, Saskatoon, Sask.), *Water Pollution Research Journal of Canada*, 1994, **29**, No 2, 3, 185-202.

The characteristics of shallow riverine lakes in the Canadian Prairies are outlined. Total phosphorus concentrations were simulated in shallow riverine lakes using first order linear dynamics. Lake dynamics were characterized by 3 independent time scales based on water influx, water outflow, and sedimentation. Both inflow and outflow time scales were necessary to model lakes with non-stationary hydrographs and varying lake levels. The role of sedimentation in lake phosphorus dynamics is considered. Floods had a marked effect on the simulated total phosphorus in the Prairie lakes. Phosphorus dynamics in the Fishing lakes in the valley of the Qu'Appelle river and in the Lake of the Prairies, a reservoir on the Assiniboine river, were studied. In the Fishing Lakes, the 1974 flood established lake conditions for the next 10 years. Net sedimentation of total phosphorus was zero. **Canada**

95-0122

### Mesoscale variability in nitrogen uptake rates and the *f*-ratio during a coastal phytoplankton bloom

A. F. VEZINA (Institut Maurice Lamontagne, Mont Joli, P.Q.), *Limnology and Oceanography*, 1994, **39**, No 4, 854-868.

Measurements of nitrate and ammonium ion uptake rates and of the *f*-ratio were taken in 1990 during a summer phytoplankton bloom in the lower St. Lawrence estuary. Depending on light level, 2 distinct relationships for the *f*-ratio were found. At the 50 per cent level, the *f*-ratio was nonlinearly related to nitrate concentration but at the 10 per cent and 1 per cent levels there was no relationship between *f* and nitrate concentration; instead, a relationship was found between the

ratio and variations in stratification in the nitrate profile. A 2 tier biological system was apparent: a shallow depth food web which quickly assimilated new nitrate supplies and a deep food web that had a slower response to a varying supply. New production was inversely related to depth in the photic zone, the opposite to the vertical structure generally proposed for nitrate limited systems. The use of nitrate dependent algorithms for  $P$  prediction may not be reliable over the full 3-dimensional nitrate field. There are 38 references. **Canada**

95-0123

#### A 50-yr record of pollution by nutrients, trace metals, and organic chemicals in the St. Lawrence river

K. CARIGNAN (Université du Québec, Ste Foy), S. LORRAIN and K. LUM

*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No. 5, 1088-1100

The contamination trends of sediments in 2 sites in fluvial lakes (St. Francis and St. Louis) of the St. Lawrence river are described. Algal cyanobacteria concentrations rapidly decreased in the top 10 cm during the 1980s but showed a broad secondary peak between 1960 and 1970, consistent with higher primary productivity. In St. Francis, the composition of organic carbon, nitrogen and phosphorus peaked between 1950 and 1970 but there was no clear phosphorus/nitrogen/carbon signal in St. Louis lake. Trace metal concentrations also increased between 1960 and 1970 and decreased between 1970 and 1980 in both lakes, the surficial concentrations now approaching background levels except for cadmium which is still 5-6 times higher. The effect of river discharge was negative for chromium, lead, nickel and zinc but positive for lead. Concentrations of PCB, DDT, DDE and Dieldrin declined by a factor of 10 between the mid-1960s and early 1980s. Mirex concentrations showed no obvious trend with time. **Canada**

95-0124

#### Transport of Detroit river pollutants from lake Erie by episodic resuspension events

M. HOWDIESHILL (Indiana University, Bloomington) and J. H. PIES

*Water Science & Technology*, 1994, 28, No. 9, 1691-1697

The dependence of sediment transport from Erie Lake into Ontario watersheds was investigated by measuring the concentration of 2-chloro-4-nitrophenol and 2-chloro-4,6-dinitrophenol using gas chromatography-mass spectrometry. These compounds were derivatized with pentafluorobenzyl bromide to give ether derivatives. Their use was impeded by the fact that they originated from a single point source (the Trenton channel of the Detroit river). The study suggested that sediment loads might be controlled by episodic resuspension of near shore sediments in the eastern basin of Erie Lake. **USA**

95-0125

#### Hydrologic pathways and stormflow hydrochemistry at South creek, northeast Queensland

H. F. SENNBERT (Bern University, Switzerland), A. WEST and M. BONELLI

*Journal of Hydrology*, 1994, 162, No. 1-2, 1-21

A combined hydrological/hydrochemical investigation of short-term variations in stormflow chemistry in a 25 ° tropical rainforest catchment where overland flow was a dominant hydrological pathway involved the collection of grab samples during 2 storm events from an ephemeral gully (A), an intermittent gully (B) and the

catchment outlet. The chemical composition of 'old' water was determined by analysis of 45 baseflow samples. Although the storm events differed in magnitude, intensity and antecedent moisture conditions in South creek both resulted in decreased calcium, magnesium, sodium, silicon, chlorine, electrical conductivity, acid neutralizing capacity, alkalinity and total inorganic carbon, constant pH, increased potassium and sulphate. Similar stormflow patterns were observed during the first storm event in gully A while a dampened 'new' water signal in gully B indicated less generation of overland flow in this sub-catchment. During the second storm event gully A flow consisted purely of subsurface stormflow and there was even less overland flow contribution to gully B flow. Stormflow water chemistry reflected temporal variation in 'new' water due to changing hydro-meteorological conditions in addition to the simple mixing of 'old' and 'new' waters and independent identification of hydrological pathways was important. **Australia**

95-0126\*

#### Groundwater quality assessment of the central Oklahoma aquifer, Oklahoma-analysis of available water-quality data through 1987

D. L. PAKKURST, S. C. CHRISTENSON and J. L. SCHLOTTMANN

U.S. Government Printing Office, Washington, D.C., Water Supply Paper No. 2257-B, 1994, 74pp

The central Oklahoma aquifer underlies over 30000 sq miles of the central portion of the State and is used extensively for municipal, industrial, commercial and domestic water supplies. The supply is drawn from a variety of water-bearing formations and the quality of water is affected by neighbouring geologic local conditions and also by the geologic activities within these groundwater linkers. An Force Base. Between 1970 and 1985 the volume of water abstracted for public supply tripled from 10000 acre ft in 1970 to 30000 acre ft in 1985 while other uses remained roughly the same. Much of the demand is met by deciduous forest and the bulk of the population reside within the 5 major towns or cities. This report presents a compilation of composition data obtained by sampling and analysis of 1004 wells and 409 distribution systems for the purpose of comparison with the Maximum Contaminant Levels (MCL) specified in the Drinking Water Quality Standard. The data in respect of 11 inorganic constituents are assembled together with measurements of radioactivity and organic contaminants where appropriate. Exceedance of MCL values were frequently encountered for a range of parameters including dissolved solids, sulphate and chloride and trace metals. There were also significant concentrations of uranium in water from parts of the aquifer. The report was prepared in 1988. **USA**

95-0127

#### Coming to grips with the GLE

G. BURK (Director of Unifac, Ottawa), Mich.

*Water Environment & Technology*, 1994, 6, No. 9, 58-63

The numerical limits proposed for components of any effluent discharged to any of the Great Lakes, and much of the thinking behind setting such limits, are criticised. The good intentions of the U.S. EPA's proposal for Water Quality Guidance for the Great Lakes System (popularly known as the Great Lakes Initiative) are not doubted, but the Agency has concentrated on point source input which are probably contributing less of certain elements singled out as culprits than derive from non-point sources including rain. The counter argument that atmospheric depositions will be controlled under other legislation does not alter the fact that a major cause of



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95-0138

### Temporal variations in lead concentrations and isotopic composition in the southern California bight.

S. A. SANUCCI, W. HELLMY (California University, Santa Cruz), and A. R. FLEGAL.

*Geochimica et Cosmochimica Acta*, 1994, 58, No 15, 3315-3320.  
Trace metal clean techniques were used to collect samples of surface water, aerosol, wastewater and petrol along the southern California bight during 1988-1989. Comparison of surface water lead concentrations with published 1976 concentrations showed a decrease from more than 170 to less than 60 pM which paralleled the 5-fold decrease in anthropogenic inputs of industrial lead. Mass balance calculations indicated that upwelling had become the primary source of lead and the isotopic composition of surface waters was characteristic of industrial lead aerosols deposited to north Pacific oceanic waters. However, the isotopic composition of surface waters in the southern reach showed evidence of increased contamination by contemporary industrial lead emissions from Mexico. The anomalous isotopic composition of the semi-enclosed San Diego bay surface waters was attributed to persistent cycling of industrial lead deposited before 1964 when wastewater discharges to the bay were eliminated. There are 32 references. **U.S.A.**

95-0139

### Origins and processing of organic matter in the Amazon river as indicated by carbohydrates and amino acids.

J. L. HEDGES (Washington University, Seattle), G. L. COWIE, J. L. RICHLEY, P. D. QUAY, R. BENDER, M. STROM and B. R. FORSBERG.

*Limnology and Oceanography*, 1994, 39, No 4, 743-761.  
Flux-weighted samples of coarse and fine particulate organic matter and ultrafiltered dissolved organic material were collected in 1990 from 3 mainstream and 6 major tributary sites along the Amazon river and analysed for total nitrogen, suspended solids, TOC, DOC, amino acid, carbon 13:carbon 14 ratios and aldose. Concentrations of TOC were fairly uniform at all sites, between 450 and 650  $\mu\text{M}$  with DOC comprising the major component. An average of 77 per cent total DOC was isolated by ultrafiltration. The coarse, fine and dissolved organic fractions showed considerable composition differences. The dissolved fractions had the poorest nitrogen content with a carbon:nitrogen ratio of 27-52 and the fine particulate samples were the most nitrogen rich with a nitrogen:carbon ratio of 9. Fine particulates consistently gave the greatest yields of amino acids. Coarse particles gave site-dependent results which ranged from not detectable to about 50 per cent of the fine particle results. The ultrafiltered samples gave very low amino acid results but like those of the fine particulates, were not significantly site-related. Dissolved organic fractions gave consistently low yields of aldoses at all sites. Coarse fractions showed extremely low aldose yields at tributary sites but not at mainstream locations. These results are consistent with a model in which highly degraded leaf material is solubilized and then partitioned between soil material and water during transport to the river. This results in suspended fine particulate organic material that is nitrogen rich and coexisting dissolved organic substances that are nitrogen poor. There are 47 references. **Brazil**

95-0140

### Patterns in planktonic P/R ratios in lakes: influence of lake trophy and dissolved organic carbon.

P. A. del GIORGIO (McGill University, Montreal, P.Q.), and R. H. PETERS.

*Limnology and Oceanography*, 1994, 39, No 4, 772-787.  
The hypothesis that planktonic photosynthesis to respiration ratios reflect gradients in both nutrient enrichment and DOC was tested in a study of planktonic metabolism in 20 southern Quebec lakes in 1991. Mean epilimnetic phytoplankton photosynthesis ranged from 8 to 377 mg carbon per  $\text{m}^3$  d and the amount of carbon respired by the plankton in excess of this ranged from 30 to 86 mg carbon per  $\text{m}^3$  d. During the growing season, plankton community respiration was between 2 and 8 times greater than phytoplankton photosynthesis in all oligotrophic and mesotrophic lakes but the imbalance was less marked in the more productive lakes. Photosynthesis to respiration ratios correlated positively with chlorophyll and inversely with water colour and DOC concentration. DOC had a depressing effect on phytoplankton photosynthesis, and this had an almost exclusive influence on photosynthesis to respiration ratios, but DOC had no statistical effect on respiration. The calculated DOC loading for the lakes indicates that net carbon loss from respiration in excess of photosynthesis is comparable to the estimated DOC loss from within the lakes and that summer plankton metabolism might be supported by external DOC exports to the lakes. Estimates of respiratory carbon dioxide production from the pelagic of the lakes are from 11 to 60 mmol carbon dioxide per  $\text{m}^2$  d, depending on DOC concentration and lake trophy. These estimates suggested that planktonic metabolism of allochthonous DOC probably constituted a major source of carbon dioxide in lakes. There are 39 references. **Canada**

95-0141

### Application of three-dimensional oil spill model (WOSM/OIL-MAP) to hindcast the Braer spill.

M. L. SPAULDING (Applied Science Associates, Inc., Narragansett, R.I., U.S.A.), V. S. KOLLURU, E. ANDERSON and L. HOWLETT.

*Spill Science & Technology Bulletin*, 1994, 1, No 1, 25-38.  
A 3-dimensional model (WOSM/OIL-MAP) which includes advection, spreading, evaporation, emulsification, entrainment, shoreline effects and subsurface transport, was applied retrospectively to the Braer oil spill off Shetland. The predictions of surface and subsurface oil paths, shoreline oiling, and subsurface oil distributions were in reasonable agreement with the observed events, but would have been improved by a smaller grid representation of the area, a sedimentation algorithm, and better data on oil concentrations. Running the model without subsurface transport gave very different results and showed the importance of this process in predicting distribution. **International**

95-0142

### Oil spill modelling using parallel computations.

H. M. CEKIRGE (Florida State University, Tallahassee), C. P. GIAMMONA, J. BERLIN, C. LONG, M. KOCH and R. JAMALI.

*Spill Science & Technology Bulletin*, 1994, 1, No 1, 61-68.  
The present status of oil spill modelling is described, and the physical and chemical processes which need to be incorporated into an ideal model are explained. The advantages of using a parallel processing computer for this are discussed. A supercomputer model was rewritten for a parallel processing machine and applied to data from the 1991 oil spill in the Arabian gulf. This gave predictions of the leading

edge of the oil spill during the first 10 d which were close to the actual positions. Parallel processing computers can run an oil spill model very rapidly and allow various hypotheses to be evaluated in the time needed for management decisions to be made. U.S.A.

## 95-0143

**Hydrocarbons in seawater and sediment from the west coast of peninsular Malaysia.**

A. R. ABDULLAH (Malaya University, Kuala Lumpur), N. M. FAHIR and L. K. WEI

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 4, 618-626

Fluorimetric analysis of samples of water and surface sediments collected from near coastal stations along the Malacca straits showed that total hydrocarbon concentrations (THC) ranged from 0.05 to 0.486 mg per litre Selig crude oil equivalent and 52.63 to 733.74 mg per kg dry weight Selig crude oil equivalents, respectively. Elevated THC in waters were associated with higher intensity of maritime activities including fishing, ferry operation, port areas, taxi fares and oil refinery runoff and with urban runoff. Coastal waters along recreational beaches had significantly lower THC. Most sediment samples contained more than 100 mg THC per kg dry weight and stations with high water THC usually had relatively high sediment THC. Sediment THC exhibited fewer seasonal fluctuations than water concentrations and coarse grained sediment had lower THC than samples containing mud and sand. Measured THC and values reported for other regions with comparable shipping activities demonstrated there was widespread pollution in the Malacca straits, Malaysia.

## 95-0144

**Input and dynamic behaviour of the organic pollutants tetrachloroethene, atrazine and NTA in a lake: a study combining mathematical modelling and field measurements**  
M. M. UERICH (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf), S. R. MÜLLER, H. P. SINGER, D. M. IMBODEN and R. P. SCHWARZENBACH

*Environmental Science & Technology*, 1994, 28, No 9, 1674-1685  
A study was undertaken to quantify the inputs and processes determining the spatial and temporal distribution of 3 diverse organic pollutants: tetrachloroethene, atrazine and nitrobenzene in a lake (Grödensee, Switzerland). Field data were used in combination with the simulation software MASAS (Modelling of Anthropogenic Substances in Aquatic Systems). For all 3 compounds, the input and seasonal variation in the vertical distribution were successfully described by applying simple box models and a one-dimensional vertical model. The results demonstrated the usefulness of combining mathematical models with field data to assess the environmental behaviour of pollutants. There are 36 references. Switzerland

## 95-0145

**Lindane residues in the water of the Iliki lake, Greece.**

G. E. MILIADIS (Benaki Phytopathological Institute, Kifissia)  
*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 4, 598-602

Residues of the insecticide lindane, but no other pesticides, were detected by gas chromatography in all water samples collected monthly for a 2-year period from the reservoir where Iliki lake water was stored prior to treatment. The response of the electron capture detector was linear in the range 0.001-0.02 ng with a correlation coefficient of 0.994. Seasonal fluctuations of lindane concentrations

in lake water reflected variations in precipitation and water volume and maximal residues (approximately 15 ng per litre) occurred in October during both years of the study period, indicating the agricultural source of the contaminant. Minimal residues (approximately 3 ng per litre) were recorded in summer. Although lindane residues in Iliki lake were below the EC maximal acceptable concentration (100 ng per litre) and the lake was generally used for potable supplies during summer months when concentrations were lowest, it is recommended that land within 1500 m of the shore should not be cultivated. Gr.

## 95-0146

**Co-operation for achieving a better protection of water resources.**

J. M. PHILIPOT (Compagnie Generale des Eaux, Paris, France)  
*Water Supply*, 1994, 12, No 1-2, IR 2-1, IR 2-8

An overview on the co-operation for achieving better protection of water resources is presented as an introduction to national reports. Water utilities alone could not control many types of pollution without the co-operation of other interested parties, examples being pollution from nitrate, pesticides, nuclear power stations, acid rain, nutrients, salinity and accidental discharges. Examples of actions within several countries included the management of floods and droughts, the reduction of the effects of accidental pollution, restrictions on agricultural and railway use of pesticides, the transfer of crop treatment products to groundwater, and rivers, and the integrated management of catchments. The protection of the Rhine river and Geneva lake are examples of successful international co-operation but much more is required. Details of these projects are provided. International

## 95-0147

**National Report: the Netherlands.**

E. W. C. A. van BREESEN (N.V. Waterwinningsbedrijf Brabantsche Biesbosch, Werkendam) and J. WILLEMSEN ZWAAUSTR  
*Water Supply*, 1994, 12, No 1-2, IR 2-20, IR 2-22

The Dutch view on the co-operation needed for achieving a better protection of water resources is presented. The quality of Rhine river water had been given international attention since 1970 and more so following the Sandoz incident in 1986. Objectives had been formulated in the Rhine Action Programme. The Meuse river was still considerably polluted, requiring advanced treatment before storing in dunes near the Hague. An international consultative body was needed; information would probably be stimulated indirectly by the North Sea Action Plan. Neither river satisfied all the standards proposed for them. Netherlands

## 95-0148

**History repeats itself in the Worcester drinking water incident.**  
*INDS Report*, 1994, No 235, IR 2-1

An independent inquiry set up by Severn-Trent Water into the Severn river drinking water pollution incident of April 1994 found that warning signals had been overlooked and that monitoring arrangements were inadequate. The Barbourne water works was not protected by backside storage nor were there standby powdered activated carbon dosing facilities. 2 of the recommendations of the Dee incident report. The inquiry team made recommendations directed at Severn-Trent Water, water companies generally, the government and the National Rivers Authority, some of which would have implications for businesses storing chemicals and handling and treating waste. U.K.

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95-0149\*

### **The Drinking Water Inspectorate: Proceedings of workshop on *Cryptosporidium* in water supplies.**

A. DAWSON, and A. FLOYD (editors)

*H.M. Stationery Office London 1994 56pp*

This publication includes a series of expert reviews of the present position regarding the frequency of occurrence of *Cryptosporidium* oocysts in water supplies in the U.K. and the implications in terms of a risk to public health. Followed by a summary of points raised during the ensuing discussions. In addition several key issues were discussed at 3 parallel workshop sessions concerned with questions of methodology and analysis, health aspects and water treatment. The relevant questions and the collective responses of the participants are presented. Finally a summary of the key points arising from the earlier proceedings is given as a basis for further action both in respect of the necessary methodology and rapid recognition of risks to health and the establishment of effective incident control procedures. U.K.

95-0150\*

### **Determination of kinetic decay factors to model chlorine in water supply distribution systems**

P. L. BURGESS (Sydney Water Board), D. C. VILANAGI, A. H. MORTON, and P. J. BEISS

*HYDROTOP 94 Colloque Mieux gérer l'Eau Marseille France Volume 2 1994, 143-151 (in English)*

The Sydney Water Board, NSW, Australia, was carrying out a research project with the object of modelling chlorine decay within different parts of its distribution system for potable supplies. Two sections were selected, one receiving filtered and the other unfiltered water, as a basis for initial trials. In each section an intensive real-time monitoring programme was instituted to provide data for calculation of a first order rate constant  $R$  governing the disappearance of the chlorine residual in selected portions of the network. Calculated  $k$  values were then employed in a dynamic water quality model (Stoner Work Station) to produce estimates of the magnitude of the chlorine residual throughout each section. The results showed that values of  $k$  could be coupled with estimates of the travel time to obtain predicted values for the chlorine residual in the trunk mains and in certain other parts of the network.  $k$  values for the filtered water network were generally less than those for the unfiltered water network, a finding which agreed with the results of static decay measurements using the respective waters. Australia

95-0151

### **Water quality in the Windy city.**

C. D. CARROLL (Metropolitan Water Reclamation District of Greater Chicago)

*Water Environment & Technology 1994 6, No 9, 52-56*

An outline is presented of the efforts of the municipal authorities of Chicago and adjacent areas to supply drinking water conforming to standards present at various times stretching back about a century, and to prevent pollution of their source, Michigan lake, by liquid wastes of diverse origins. This historical account reveals the changes in the approach to water quality conservation forced upon the authorities by population growth and industrialization. Initially, it was considered that the lake's volume could comfortably accommodate wastes discharged to it; later on it was thought that sufficient protection of drinking water would be ensured by moving intakes further away from the lake shore. The change of attitude to an environmentally caring and health preserving one has entailed closed integration of scientific discoveries and improved technology

with administrative and regulatory agencies required to ensure that they are employed to the best advantage. The origins and scope of these are set out, and examples of projects undertaken at their behest, and of their success, are included. Highlighted are on going schemes to eliminate sewage overflows into the lake or its feeder streams by a system of interceptor sewers, sewage-storing reservoirs, and pumping to sewage works, raising the oxygen content of drinking water sources by submitting a portion to artificial in channel cascading by a curved weir, and clean up of sediments whose toxic components have begun to affect the aquatic food chain in the lake. Future plans aimed at incorporating flood control measures into the sewer overflow reduction schemes already in hand are mentioned. U.S.A.

95-0152

### **Biofilm development on surfaces in drinking water distribution systems.**

D. van der KOOIJ (KIWA N.V. Research and Consultancy Nieuwegein) and H. R. VEENDAM

*Water Supply 1994 12, No 1/2, SS 1-1 SS 1-7*

The growth of Biofilm in water supply distribution systems caused both water quality and materials in the system to deteriorate. The extent of growth as measured by enumerating colonies of heterotrophic bacteria, was closely related to the easily assimilable organic carbon (AOC) in the potable water leaving the treatment plant. New growth was severely limited when AOC was kept below 10 µg per litre and there was little change in AOC during the water's sojourn in the distribution system. The position was complicated by the presence of ammonia and methane which promoted *Acetomonas* spp. A technique of assessing the biofilm formation characteristics of drinking water was developed in which water was passed at 0.2 m per second through glass cylinders forming a column. Periodically up to 2 cylinders were removed, biofilm ultrasonically dislodged and biomass measured as adenosine triphosphate (ATP). The promotion of bacterial growth by materials commonly used in water installations was also assessed by ATP analyses. There are 42 references. Netherlands

95-0153

### **Health implications of arsenic in drinking water.**

F. W. PONTIUS (American Water Works Association, Denver, Colorado), K. G. BROWN, and C. T. HEN

*Journal of American Water Works Association 1994 86, No 9, 52-63*

The chemical characteristics of arsenic and the common arsenic compounds found in the environment are described. Humans are exposed to arsenic primarily via air, food and water. Arsenic in drinking water is mostly in the easily absorbed arsenate form. The pharmacokinetics and mechanisms of arsenic in humans are not completely understood. Additional research is needed to enable a safe exposure level to be determined. Acute toxicity, chronic noncarcinogenic toxicity and the link between ingested arsenic and cancer are discussed. If theoretical estimates of chronic effects and cancer risk were proved accurate, then the existing maximal contaminant level of 0.05 mg per litre may not protect health. There are 85 references. U.S.A.

## MONITORING AND ANALYSIS OF WATER AND WASTES

See also Abstracts 95-0023

95-0154

**Multiplex PCR for detection of the heat-labile toxin gene and shiga-like toxin I and II genes in *Escherichia coli* isolated from natural waters**

A. L. LANG (Orange County Sanitation Districts, Fountain Valley, Calif.), Y. L. TSAI, C. L. MAYER, K. C. PATTON, and C. J. PALMER

*Applied and Environmental Microbiology*, 1994, 60, No 9, 3145-3149

A triplex polymerase chain reaction (PCR) method was developed for the simultaneous screening of *Escherichia coli* for shiga-like toxin I (STxI), shiga-like toxin II (STxII), and heat-labile toxin (LT) homologous sequences. Amplification and screening of a random sample of 577 *E. coli* isolates from 2 marine environments by PCR and internal oligonucleotide probe hybridization indicated that only 1 isolate was an enterotoxigenic strain containing an LT homologous sequence, and only 1 isolate was an enterohaemorrhagic strain containing an STxII homologous sequence; no STxI homologous sequences were detected. These results were confirmed by Southern analysis, seeding experiments and tests for the presence of the *uidA* gene. Standard bioassays with Vero cells and Vero cells expressing toxin production by the positive environmental isolates and the proposed triplex PCR method could be used for the rapid screening of large samples for potentially pathogenic *E. coli*. There are 3 references. U.S.A.

95-0155

**An immunological assay for detection and enumeration of thermophilic biominer microorganisms**

A. M. AMARO (Unica University), K. B. HALLBERG, L. B. HENDSTROM, and C. A. HRIEZ

*Applied and Environmental Microbiology*, 1994, 60, No 9, 3170-3174

A radioactive immunobinding assay was developed for monitoring strains of the moderate thermophile *Thiobacillus caldus* and the extreme thermophilic archaeon *Sulfolobus acidocaldarius* in industrial bioleaching systems. Samples were applied to a nitrocellulose membrane using a dot blot apparatus and the bound immunoglobulins were detected using either peroxidase-conjugated antibodies or a commercially available enhanced chemiluminescence method. The slot and blot immunobinding assays were rapid, efficient, specific and sensitive, and enabled simultaneous identification and enumeration but could not distinguish between live and dead cells and were presently applicable only to cells in liquid suspension. Sweden

95-0156

**Survival of allochthonous bacteria in still mineral water bottled in polyvinyl chloride (PVC) and glass**

F. MOREIRA (Universidade de Coimbra), P. AGOSTINHO, P. V. MORAIS, and M. S. da COSTA

*Journal of Applied Bacteriology*, 1994, 77, No 3, 334-339

The survival of *Escherichia coli*, *Enterobacter cloacae*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* in bottled still mineral water was investigated. Survival was assessed in still water in PVC containers in the presence and absence of autochthonous bacteria

flora in sterile mineral water in glass bottles, and in sterile tap water in glass containers. The viable counts of the 3 enterobacteria decreased under all experimental conditions but the decrease depended on the organism and conditions. *E. coli* decreased rapidly in mineral water, particularly in mineral water bottled in PVC, irrespective of the presence or absence of autochthonous bacteria. *E. cloacae* had a very low and constant mortality rate allowing it to persist in mineral waters for very long periods. *P. aeruginosa* grew in tap water. After a sharp initial decrease in culturability, *P. aeruginosa* had a low mortality rate in sterile and non-sterile mineral water bottled in PVC and in sterile mineral water bottled in glass. There are 14 references. Portugal

95-0157

**Survival of genetically-marked *Aeromonas hydrophila* in water** D. LOWE, C. K. (Liverpool University), and C. EDWARDS

*Letters in Applied Microbiology*, 1994, 19, No 3, 121-124

The survival of the pathogen *Aeromonas hydrophila* in seawater and lake water was investigated. *A. hydrophila* cells were genetically marked with plasmid pLV1013 which encodes the *catE* gene. The stability of transformed *A. hydrophila* in sterile lake water was tested at 4, 10 and 20°C. Survival was best at 20°C and loss of viability was only significant at 4°C. There was no plasmid loss. In non-sterile lake water, survival fell rapidly, possibly reflecting the inability of *A. hydrophila* to compete with indigenous species. Loss of the plasmid occurred in a proportion of the cells. In seawater, cell numbers decreased rapidly during the first 9 d, recovered up to day 12 and then decreased up to 28 d. Plasmid loss was observed. U.K.

95-0158

**Microbiological quality of bottled water in Greece**

A. MAVRIKIOU (Piraeus University), M. PAPAPETROPOULOU, P. BOLEA, M. LAMURE, and L. A. PAPADAKIS

*Letters in Applied Microbiology*, 1994, 19, No 4, 213-216

A collaborative study, conducted by 3 Greek laboratories, which monitored over the microbiological quality of bottled water produced in the country, is reported. The study was considered necessary, as the number of factories in production had grown in order to keep pace with the demand, mainly from tourists. Bottled waters can be classified as either natural mineral water (in which case it has to conform with Greek standards, derived from those of the EC, for such water, these forbid disinfection) or as table water (where disinfection is permitted). Data were collected over 5 years (1987-1992) on the presence of coliforms, enterococci, *Escherichia coli*, *Pseudomonas aeruginosa*, other *Pseudomonas* species, and *Clostridium perfringens*. Of the total of over 3000 samples, nearly one third failed to meet the standards, the failure rate being higher for table waters, despite their permitted disinfection. The failure rate was lower in those factories having their own microbiology laboratory, and the count of all bacteria declined sharply after 1990, when regular checking of all the factories was introduced. The presence of *Pseudomonas* of various species was worrying, as some have been shown in other studies to be resistant to clinically available antimicrobial agents, and may pass on this resistance to other pathogenic organisms currently susceptible to them. Greece

## MONITORING AND ANALYSIS

95-0159

**A comparison of the toxicity of 50 reference chemicals to freshly isolated rainbow trout hepatocytes and *Daphnia magna*.** H. T. ILIUS (Åbo Akademi University, Turku, Åbo), B. ISOMAA, and I. HOLMSTROM

*Aquatic Toxicology*, 1994, 30, No 1, 47-60

Fifty reference chemicals were used to evaluate toxicity screening tests which measured immobility in *Daphnia magna* during 24 h incubation and rubidium 86 leakage from freshly isolated rainbow trout hepatocytes in 3 h. Regression analysis of the EC<sub>50</sub> values from each test gave a correlation of 0.71 and a slope of 0.68 for the regression line. The *Daphnia* test was more sensitive to the chemicals than the hepatocyte test. Published results from mammalian hepatocyte toxicity tests with a 24 h incubation showed that these were also less sensitive than the *Daphnia* test. A more sensitive endpoint than loss of membrane activity would be needed before isolated cell culture could be used for routine toxicity testing. **Finland**

95-0160

**Organochlorine pesticide compounds in organisms from the bay of Bengal.**

M. S. SHAIL AJA (National Institute of Oceanography, Dona Paula, Goa), and S. Y. S. SINGHAI

*Estuarine, Coastal and Shelf Science*, 1994, 39, No 3, 219-226

Studies were undertaken to determine organochlorine pesticide residue levels in some species of bottom feeding fish sampled from the Bengal bay. A few samples of zooplankton obtained from surface waters were also examined to obtain a more comprehensive view of the distribution of these compounds, specifically DDT, DDD, DDE and aldrin. Concentrations of total DDT (DDT, DDD and DDE) ranged from 1.31 to 115.90 ng per g wet weight in different fish tissues and 4.0 to 1587.76 ng per g wet weight in zooplankton. Distributions of the compounds in different fish tissues, differences in the proportion of DDT and its metabolites in various organisms, and the influence of suspended particulates on the availability of DDT residues to organisms were examined. **India**

95-0161\*

**Monitoring of marine communities around the outfall from the Cassis municipal sewage treatment plant (Rhine delta region).**

E. CHARBONNET (Faculté des Sciences de Luminy, Marseille), C. F. BOUDOURESQUE, M. BOURCHER, P. FRANCOUR, and P. BOUDOURESQUE

*HYDROTOP 94. Colloque. Mieux gérer l'Eau. Marseille. Volume 2*, 1994, 522-528 (in French, English summary)

Detailed studies were carried out along 2 transects extending from the shoreline of the nature and abundance of selected marine organisms, to estimate the effects of the Cassis marine outfall on the communities present in the Cassis bay. The studies included the bioocenosis inhabiting both the mobile and rocky bottom sediments, together with planktivorous and detritivorous fish species, and stands of the seaweed *Posidonia oceanica* which had previously regressed. Relative to the data obtained following a similar survey in 1981, the seaweed beds had stabilized and the pollution effects attributed to the sea outfall could be described as moderate, although nevertheless distinguishable from background levels in the area, where the general level of pollution has been declining. Some additional pollution indices were established on the basis of this survey which will form a point of reference for future investigations. **France**

95-0162

**Are the Mediterranean waters becoming warmer? Information from biological indicators.**

P. FRANCOUR (Laboratoire de Biologie Marine et d'Ecologie du Benthos, Marseille), C. F. BOUDOURESQUE, J. G. HARMELIN, M. L. HARMELIN-VIVIEN, and J. P. QUIGNARD

*Marine Pollution Bulletin*, 1994, 28, No 9, 523-526

An increase in the average temperature of the waters of the western Mediterranean basin has been observed since the 1960s. The distribution of marine species with well-established temperature preferences was studied at 3 sites: Port Cros National Park in France, the National Reserve of Scandola (Corsica) and the Golfe du Lion. At Scandola the frequency of 2 thermophilic algal species, *Dasycladus armicularis* and *Digena simplex* increased from 1989-1992. Two other less thermophilic species (*Halophilys incurvus* and *Stypocaulon scoparium*) regressed during the same time. The abundance of thermophilic Echinodermata species at Scandola and Port Cros increased between 1983 and 1992. Fish species common in the warmer eastern Mediterranean, eg *Thalassoma pavo*, were observed for the first time in the western sites. The causes of the change in distribution of the thermophilic species are discussed. There are 37 references. **France**

95-0163

**Contaminant monitoring studies using marine mammals and the need for establishment of an International Environmental Specimen Bank.**

N. MIYAZAKI (Tokyo University, Iwate)

*Science of the Total Environment*, 1994, 154, No 2/3, 249-256

The need for establishing an environmental specimen bank for archiving marine biological and environmental samples for retrospective analysis is outlined. Marine mammals could be suitable indicators of marine pollution as they are the top predators in marine ecosystems and have long life spans. Environmental studies on the accumulation of metals (iron, manganese, zinc, copper, lead, nickel, cadmium, mercury) and organochlorines (DDT, PCB, HCH) in marine mammals are reviewed. Placental transfer of contaminants, the transfer of contaminants through lactation, the biological impact of contaminants on marine mammals, and the global movement of contaminants are considered. The history of international environmental specimen banking is described and the establishment of an International Environmental Specimen Bank for marine mammals and other marine organisms is recommended. **Japan**

95-0164

**Chlorinated hydrocarbon contaminants in arctic marine mammals.**

R. J. NORSTROM (Environment Canada, Hull, PQ), and D. C. G. MUIR

*Science of the Total Environment*, 1994, 154, No 2/3, 107-128

The bioaccumulation and metabolism of chlorinated hydrocarbon contaminants (CHC) in the food chain of Arctic marine mammals are reviewed. The Arctic marine mammals include the fur seal (*Callorhinus ursinus*), harp seal (*Phoca groenlandica*), minke whale (*Balaenoptera acutorostrata*), bowhead whale (*Balaena mysticetus*), beluga (*Delphinapterus leucas*), narwhal (*Monodon monoceros*), bearded seal (*Ergasilus barbatus*), porpoise (*Phocoena phocoena*), walrus (*Odobenus rosmarus*), and polar bear (*Ursus maritimus*). The identification of CHC in Arctic marine food chains is reviewed and the distribution of different classes of CHC, eg DDT, PCB, chlordanes, and polychlorinated camphenes, is considered. Changes

in contaminant patterns due to metabolism in marine mammals present levels of CHC in Arctic marine mammals, the use of marine mammals as indicators of CHC disposition in the Arctic, and temporal trends and ecotoxicology of CHC contamination in Arctic marine mammals are reviewed. There are 108 references. **Canada**

95-0165

#### Use of model parameter estimations from standard fish toxicity tests to indicate toxic mechanisms.

R. T. VAN WINK (Akzo Corporate Research Laboratories, Veenendaal) and R. KRAAIJ

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No. 2, 171-178

The use of information on the mode of toxic action of chemicals to predict the toxicity of mixtures of compounds in standard fish toxicity tests was investigated. A statistical approach was used to indicate different toxic response characteristics by deriving parameters from the results of modelling the concentration-time response surfaces of standard acute toxicity tests with *Brachydanio rerio* (zebrafish). Chemicals with a narcotic mode of action, electrophilic compounds, acetylcholinesterase inhibitors, and potassium channel blockers were used in the tests. Results obtained with the statistical modelling approach indicated the potential usefulness of this approach in the prediction of environmental hazards. **Netherlands**

95-0166

#### Estimation of appropriate background concentrations for assessing mercury contamination in fish.

C. K. SOUTHWORTH (Oak Ridge National Laboratory, Tennessee) and M. J. PETERSON, S. M. ADAMS, and B. G. BEAULOCK

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No. 2, 211-218

Mercury concentrations in bluegill and redear sunfish (*Lepomis macrochirus* and *Lepomis microlophus*, respectively) from stream and reservoir in Oak Ridge, Tennessee, were measured to determine appropriate background levels for assessing mercury contamination in fish. The measurements were made in stream and lakes presumed to be relatively unaffected by point sources of anthropogenic mercury. Inter-specific differences in mercury bioaccumulation were examined. Mean mercury concentrations suggested that species could be used to estimate background levels in other parts of the region. Differences between the species in contamination, however, indicated the need for caution in combining data from different species. **USA**

95-0167

#### Bioaccumulation of heavy metals and organochlorines in a lake ecosystem with special reference to bream (*Abramis brama* L.)

W. SCHARENBERG (Institut für Toxikologie, Köln), P. GRAMANN, and W. H. PETERLIN

*Science of the Total Environment*, 1994, 155, No. 1, 187-197

The effects of environmental contaminants on the fate of material in a lake ecosystem was investigated by determining the concentration of heavy metals and organochlorines (OC) in bream (*Abramis brama* L.), piscivorous fish, and zooplankton collected over a 4-year period in Belin lake where anthropogenic influences were relatively small. Regression analysis indicated that seasonal variations in heavy metal or organochlorine concentrations of bream homogenates were not explained by weight differences. Maximal concentrations of toxic metals and organochlorines in bream were generally considerably lower than the limits for edible freshwater fish but higher chlorinated

PB congeners were extremely variable and could exceed these limits in individual fish. Roach (*Rutilus rutilus*) showed slightly higher metal concentrations in muscle and ovarian tissue than pike (*Esox lucius*). Mercury was the only metal accumulated from plankton to fish and organochlorine biomagnification was undetectable on the basis of dry weight. There was no evidence that Belin lake fish were damaged by metal and organochlorine residues but synergistic effects were possible. Bream were good indicators for the contamination status of freshwater lakes. There are 42 references. **Germany**

95-0168

#### Radionuclide concentrations in white sturgeons from the Hanford reach of the Columbia River

D. D. DAUBIE (Pacific Northwest Laboratory, Richland, Wash.) and L. M. POSTON

*Transactions of the American Fisheries Society*, 1994, 123, No. 4, 565-573

From 1944 to 1971, one to eight plutonium production reactors were operated at the Hanford site, with U.S.A. Radioactive materials were released to the Columbia river from 1957 to the mid 1960s. Historical data on radionuclide concentrations in white sturgeons (*Acipenser transmontanus*) in the Hanford reach of the Columbia river were obtained from a review monitoring studies. Present day tissue burdens were determined and compared with historical concentrations from 1953. Studies conducted during 1953-1955 showed that high concentrations of radionuclides were present in white sturgeons. Average concentrations were 1480 Bq per kg for liver and kidney, and greater than 2000 Bq per kg for fins and scales. The principal radionuclides in the fish tissue during 1963-1967 were phosphorus-32, zinc-65, and chromium-51. Radionuclide concentrations were greater in the gut contents than the carcass and muscle. Studies in 1989-1990 showed a marked decrease in radionuclide concentrations in white sturgeons. Maximum concentrations of industrial radionuclides (caesium-137, cobalt-60, and strontium-90) were less than 1 Bq per kg. No other artificial radionuclides were detected. There are 34 references. **USA**

95-0169

#### Cadmium uptake from seawater and food by the western rock lobster *Panulirus cygnus*

K. A. FRANCESCONI (Western Australia Marine Research Laboratories, North Beach), L. J. MOORE, and L. S. EDMONDS

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No. 2, 219-223

Possible consequences of the discharge of cadmium containing waste near Five Fathom bank, a lobster fishing ground off Western Australia, were examined. Probable levels of cadmium in rock lobsters (*Panulirus cygnus*) from the area were considered in relation to the maximal permissible concentration in crustaceans. The study suggested that cadmium levels in *P. cygnus* would not be significantly increased by uptake from seawater as a result of the proposed discharge, through other organisms in the same waters, including mussels, could accumulate cadmium, possibly giving rise to higher levels in lobster through food chain bioaccumulation. **Australia**

## MONITORING AND ANALYSIS

95-0170

### Silver uptake by the oyster (*Crassostrea virginica*): effect of organism size and storage sites.

G. R. ABBE (Academy of Natural Sciences, Benedict, Md.) J. G. SANDERS and G. F. RIEDEL

*Estuarine, Coastal and Shelf Science*, 1994, 39, No 3, 249-260

The effect of oyster size on silver accumulation and the sites in large oysters in which silver was principally stored were investigated. Three sizes of hatchery-reared oysters were exposed to 0, 2 and 7 µg per litre of added silver for 1 and 2 weeks. Tissue concentrations of exposed oysters generally increased with exposure concentration and duration for all sizes. Body burdens generally increased with size, though small oysters showed higher concentrations because of large dry weight differences. Large oysters were monitored before and after spawning. Before spawning, the highest concentrations were found in the gonads, while in post-spawning oysters concentrations in gills and mantle were higher. There are 18 references. U.S.A.

95-0171

### Accumulation and toxicity of iron and manganese in *Spirodela polyrrhiza* (L.) Schleiden.

S. SINHA (National Botanical Research Institute, Lucknow), I. N. RAI and P. CHANDRA

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 4, 610-617

Samples of the aquatic macrophyte *Spirodela polyrrhiza* collected from several locations in a pond contaminated by industrial effluents and agricultural runoff contained 71.0 µmol per g iron and 22.7 µmol per g manganese compared to 30.8 µmol per g iron and 2.5 µmol per g manganese in pondwater. Laboratory experiments in which fronds of *S. polyrrhiza* collected from an unplugged water body were exposed to 5 concentrations ranging from 0.01 to 0.1 mM of iron and manganese separately for up to 14 d showed a significant accumulation of both metals which increased with treatment concentration and was greater for iron than manganese. The only decrease in chlorophyll content (8.9 per cent) was recorded for the 0.1 mM manganese treatment. At the 0.1 mM concentration iron and manganese treatments resulted in 33.1 per cent and 29.4 per cent decreases, respectively, in biomass while multiplication rates (MR) decreased from 1.76 to 1.75 and to 1.04, respectively. Treatment with 0.01 mM iron and manganese did not affect biomass or chlorophyll content but decreased MR to 16.06 and 16.07, respectively, indicating there was a potential use of MR as a bioassay for very low metal concentrations in aquatic environments. India

95-0172

### Biosorption of mercury by the inactivated cells of *Pseudomonas aeruginosa* PU 21 (Rip64).

J. S. CHANG (California University, Irvine) and J. HONG

*Biotechnology & Bioengineering*, 1994, 44, No 8, 999-1006

The uptake of divalent mercury by steam-sterilized cells and cation exchange resin (AG 50W-X8) in the hydrogen form from deionized water was examined as a function of the pH, the presence of sodium chloride, and the use of a sodium phosphate buffer. No severe effects due to sodium chloride were evident, and this suggests high mercury selectivity by the biomass over the sodium ions. This was in marked contrast to the strong inhibition of the mercury uptake by the ion exchange resin with a high sodium concentration. The presence of a sodium phosphate buffer greatly enhanced the maximal mercury uptake by the inactivated *Pseudomonas aeruginosa* PU 21 (Rip64) cells when biosorption took place in a 50 mM sodium phosphate buffer at pH 7.4. In general, the maximal mercury uptake capacity

of the cation exchange resin was only about 50 per cent of the inactivated cells. U.S.A.

95-0173

### Detection of waterborne mutagens and characterization of chemicals in selected Galveston sites after an oil spill.

S. KIRA (Okayama University, Japan), T. ITOH, H. HAYASHI, K. TAKETA, Y. ZHENG, R. L. T. T. HOLIDAY and C. S. GIAM

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 2, 285-291

A sampling technique developed for the determination of mutagens in marine environments was applied at sites in Galveston bay, Tex. 5-7 d after an oil spill in 1990. The pollutants found were characterized chemically and with respect to mutagenicity. The sampling technique depended on the suspension of a blue rayon adsorbent selective to polycyclic mutagens with 3 or more fused rings in the water to be sampled. The relation between the mutagenicity of the blue-rayon adsorbed compounds and the level of known mutagens in the water is considered. The technique was useful and convenient for monitoring mutagenicity in the marine environment, particularly where the sampling sites were remote from the laboratory. U.S.A.

95-0174

### Environmental soil and groundwater assessment using high resolution passive soil-gas samplers - PF-TREX method: methodology and results of a case study performed in Brazil.

D. C. GOMES, C. D. GLOKLOCK, Sao Paulo, M. M. ARSA, M. C. SALVADOR and C. KUPERSCHMID

*Water Science & Technology*, 1994, 29, No 8, 161-172

Volatile and semi-volatile organic compounds in soil were investigated by the PF-TREX method in which a passive gas sampler was placed within a 40-45 cm deep hole for 1-3 d. The monitor consisted of 2 ferromagnetic wires with activated carbon coated tips protected by a glass container. Adsorbed compounds were released by current desorption directly into the ion source of a quadrupole mass spectrometer. In some cases, separation by gas chromatography preceded mass spectrometry. Up to 9000 compounds could be detected by this method. Brazil

95-0175

### Monitoring of the pesticide levels in natural waters of the Valencia Community (Spain).

J. PICO (Universitat de Valencia, Burjassot), J. C. MOLTO, M. J. REDONDO, I. VIANA, J. MANES and G. FORT

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 2, 230-237

Capillary gas chromatography with simultaneous electron capture and nitrogen-phosphorus detection was used to monitor natural waters from the Valencia area for 72 pesticides. River, irrigation channel and lake water samples from various points in the region were analysed. Halogenated pesticides, polychlorinated biphenyls, carbonates, triazines and organophosphorus compounds were determined. Pesticide levels were in most cases lower than the limits proposed by the European Community. The implementation of a pesticide residue monitoring programme was recommended to secure an improvement in the quality of surface waters. Spain

95-0176

**Experimental work in continuous monitoring of methane in groundwater**

K. BRADSHAW (WRc Medmenham)

*Journal of Institution of Water and Environmental Management* 1994, 8, No 4, 409-416

The feasibility of using diffusion cells to determine dissolved methane at depth was established through laboratory experiments using a pressurized bomb. The diffusion cell was calibrated for pressures of 1 to 9 bar (equivalent to 90 m below water level) and for 4 methane concentrations between 0 and 100 per cent saturation at 80°C. Relative standard deviation for the method was normally between 3 and 6 per cent. Application of the method to on-site monitoring is discussed and the need for field trials was identified to confirm the laboratory findings. U.K.

95-0177

**Overview and future trends in oil spill remote sensing**

R. GOODMAN (Imperial Oil Resources Limited, Calgary, Alberta Science &amp; Technology Bulletin 1994, 1, No 1, 11-14)

Thermal, infrared, mid-infrared, near-infrared and ultraviolet sensors are presently used to supplement visual observation of oil spills, but they can only operate in certain weather or light conditions, and do not provide information on oil thickness. Side-looking airborne radar can be used under all weather conditions, but is affected by surface wind conditions. Future developments include microwave radiometers which can measure the relative thickness of oil film averaged over a large area of the slick. Laser acoustic oil thickness sensors which can measure the absolute thickness of the oil, but cannot penetrate cloud or fog, and laser fluorosensors which can detect oil slicks from below. These new methods needed to be tested in the field to verify their usefulness. Canada.

95-0178

**Monitoring network design to provide initial detection of groundwater contamination**

L. D. MEYER (Pacific Northwest Laboratory, Richland, Washington), A. J. VALOCCHI and J. W. EHLERT

*Water Resources Research* 1994, 30, No 3, 7637-7650

A method for the design of a monitoring network to provide initial detection of groundwater contamination at a wide dispersion site is proposed. The method incorporates a system of one or more of the following alternative networks which were non-inferior with respect to specified objectives. The analysis of uncertainty was conducted using Monte Carlo simulation of groundwater contaminant transport. The design objectives considered were the maximization of the number of monitoring wells, the maximization of the probability of detecting a contaminant leak, and the minimization of the expected time to contamination at the time of detection. There are 44 references. U.S.A.

95-0179\*

**The TH capacitance probe for measurement of soil water content**

T. J. DEAN

*Institute of Hydrology, Wallingford, BIR, post N 125, 1994, 39pp*

The development of a portable device for the measurement of soil water content using a capacitance probe is described. The equipment measures the electric capacitance of the soil in contact with the rods projecting from the bottom of the instrument, which is directly related to the dielectric constant. The theory of measurement at the

design of the electric circuit from which a reading may be derived are discussed and the method of operation and calibration of the equipment for surface measurements and other more specialized uses are described. Details of its calibration against soil gravimetric moisture content determinations are also given and some future possibilities for the application of the equipment are outlined. Soil density, type and structure are important factors in the calibration. The design has been patented and a license for its commercial manufacture is being negotiated. U.K.

95-0180

**Inorganic chemical fingerprinting of the environment 'reference freshwater' - a useful tool for comparison and harmonization of analytical data in freshwater chemistry**B. MARKERT (GKSS National Research Centre, Magdeburg), *Fresenius Journal of Analytical Chemistry* 1994, 349, No 10, 1169-1172

In the context of finding ways of harmonizing environmental quality analytical data from around the world, particularly in the field of instrumental multi-element analysis, a method is presented for the normalization of the data with its representation in the form of fingerprints for comparison and interpretation. Data are represented in the form of element fingerprint graphs after normalization against an artificial synthetic reference sample which did not exist in reality. A figure showing the five element concentrations of reference freshwater (in µg per litre) includes a fingerprint of Bialak Lake water normalized against the data of reference freshwater discussed and its comparison demonstrated. Information is provided on whether the data were normalized against the element concentration changed, thanks to a variable behaviour could be traced back to a changing geochemical element pattern, and changes in concentration were observed. There are 15 references. Germany.

95-0181

**The importance of element speciation in water analysis - a plea for further investigations**

J. H. FRIMMEL (University of Karlsruhe) and J. GRIMM

*Fresenius Journal of Analytical Chemistry* 1994, 350, No 1, 1-13

The term 'speciation' is popular and of importance in water analysis is explained. Other water quality confirmation number, deep-seated and environmental monitoring is a sea. Examples of water pollution, such as long-term and analysis are given. Go with a common method for the determination of organic carbon in natural compounds, such as Naphthalene, for the determination of organic carbon. Use of a method for the determination of organic carbon in natural compounds, such as Naphthalene, for the determination of organic carbon. Use of a method for the determination of organic carbon in natural compounds, such as Naphthalene, for the determination of organic carbon. There are 20 references. Germany.

95-0182

**First derivative of the ratio spectra method for resolving iodide and thiocyanate in binary mixtures**

M. MARTINEZ CALERA, M. J. C. UNIVERSITAT

MARTINEZ VIDAL and A. GARRIDO VERENICH *Talanta* 1994, 41, No 1, 41-44

A new spectrophotometric method was developed for the determination of binary mixtures of iodide and thiocyanate in power station waste water at µg per litre. The method was pre-concentration step. The method was based on the first derivative of the ratio spectra of iodide and thiocyanate formed between the common benzol-



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dioxamic acid and vanadium(V) extracted in Adogen 464 (triethyl methyl ammonium chloride) toluene solution. Calibration graphs for 2.9 µg per ml of iodine and for 2.6 µg per ml of thioximate were established by measuring the analytical signals at 376 nm for iodine and at 400.6 nm for thioximate. There are 36 references. **Spain**

95-0183

**Continuous-flow system for the accurate determination of low concentrations of ammonium ions using a gas-permeable poly(tetrafluoroethylene) tube decontaminator and an ammonia gas-sensing membrane electrode.**

H. HARA (Shiga University), and S. MATSUMOTO  
*Analyst* 1994, **119**, No 8, 1839-1842

A continuous flow system, based on a constant dilution method, is proposed for constructing a calibration graph for low concentrations of ammonium ions in lake or purified water, without risk of contamination from atmospheric ammonia. Standard solutions were prepared by diluting a limited volume of a standard ammonium chloride solution with a flow of ultra-pure water from which residual ammonium ions had been previously removed as ammonia by passage through a gas permeable PTFE tube decontaminator at pH 12. By using an ammonia gas-sensing membrane electrode as detector the measurable concentration range was between 0.1-5 µmol per dm<sup>3</sup>. The accuracy was within plus/minus 0.3 per cent and the precision for 5 independent determinations of 0.3-0.5 and 2.0 µmol per dm<sup>3</sup> ammonium chloride was in the range 0.8-1.1 per cent. The results from the analysis of Biwa lake (Japan) water are reported. **Japan**

95-0184

**Flow injection spectrophotometric determination of nitrite**

A. CHATURASTHA (Ram Durgavati University, Jabalpur), and K. K. VERMA

*Talanta* 1994, **41**, No 8, 1275-1279

In this experiment 4-nitroaniline, which gave intensely yellow solutions in dilute mineral acids, reacted almost instantaneously with nitrite in acidic media to give a colourless product identified as 4-nitrophenyl diazo cation. Measurement of decrease in reagent colour intensity in a reversed flow injection (reagent injection) system was incorporated in a new nitrite determination procedure. The limit of detection was 2 µg nitrite nitrogen per litre. Species such as copper(II) and lead(II) which interfered with other spectrophotometric procedures did not affect the proposed method. The procedure was used to determine nitrite concentrations in natural waters. **India**

95-0185

**Catalytic spectrophotometric determination of nitrite using the chloropromazine-hydrogen peroxide redox reaction in acetic acid medium**

B. LIANG (Yamanashi University, Kofu), M. IWATSUKI, and T. FUKASAWA

*Analyst* 1994, **119**, No 9, 2113-2117

A method for the determination of nitrite in water is described. The oxidation of chloropromazine hydrochloride by hydrogen peroxide in acetic acid/oxalic acid medium was catalysed by nitrite. Absorbance was measured at 528 nm for 4 minutes. The maximal absorbance occurred within 2-4 minutes and was proportional to the nitrite concentration. The effects of acidic media, order of addition of reagents, reagent concentrations, reaction temperature, and foreign ions were investigated. Reagent concentrations, with the exception

of chloropromazine hydrochloride, had little effect on the reaction. Interference by iron(III) could be masked by oxalic acid and EDTA. The calibration plot was linear for 0.1500-1.500 ng nitrate per ml. The method was applied to the determination of nitrite in rain and river water. **Japan**

95-0186

**Diethyl sulphide in North sea waters and sediments.**

D. B. NEEDWELL (Essex University, Colchester), M. T. SHABBIER, and R. M. HARRISON

*Estuarine, Coastal and Shelf Science* 1994, **39**, No 3, 209-217

Three cruises undertaken under the North Sea Community Research Programme during 1989-90 were used to measure concentrations of dimethyl sulphide (DMS) and dimethylsulphoniopropionate (DMSP) in the water column and bottom sediments at several sites in the southern North Sea. The question of whether the sediments were sites of DMS generation or accumulation was investigated. Concentrations of both compounds in the water column were higher in summer. Bottom concentrations were 3 orders of magnitude higher than those in the water column. Rates of emission were slow. Most deposited sulphur was reoxidized before emission or buried. There are 33 references. **U.K.**

95-0187

**Low-volume microwave digestion of marine biological tissues for the measurement of trace elements**

S. BALDWIN (Canberra University, Belconnen, A.C.T.), M. DEAKER, and W. MAHER

*Analyst* 1994, **119**, No 8, 1701-1704

Low volume (2 ml) Teflon vessels and microwave heating were used for the digestion of 5 marine biological tissues. SR1566 (cyster tissue), Dorville (dogfish muscle) and Fort-Lobson (crustacean) were prior to their analysis for trace elements using flame atomic absorption spectrometry (FAAS) or electrothermal atomic absorption spectrometry (ETAAS). Freeze-dried samples (ca. 0.1 g dry mass) and nitric acid (2 ml) were placed in screw-topped Teflon vessels and treated by a three-stage digestion procedure utilizing full power (600 W) followed by reduced power (150-450 W). Quantitative recoveries of copper, zinc and cadmium were obtained from the marine reference materials following digestion at 600 W for 2 minutes, 450 W for 2 minutes and 450 W for 45 minutes using nitric acid. **Australia**

95-0188

**Performance characteristics of gel probes used for measuring the chemistry of pore waters**

W. DAVISON (Manchester University), H. ZHANG, and G. W. GRIMM

*Environmental Science & Technology* 1994, **28**, No 9, 1623-1632

The use of polyacrylamide gel probes in the measurement of iron and manganese in pore waters at sub-millimetric resolution by diffusion equilibration in thin films is demonstrated. Performance characteristics for the procedure were established. Iron(II) and manganese(II) diffused freely within the gel matrix. With a 0.4 mm thick gel complete equilibration was achieved in 6 minutes. It was essential for gels to be deoxygenated prior to deployment. If exposure to air exceeded 15 seconds after this, there was a risk of overestimating iron. The greatest limit to resolution was the time from removal from the sediment to fixing or slicing the gel. **U.K.**

95-0189

**Simultaneous determination of organic ionic lead and mercury species using HPLC.**

K. C. AMMANN (Universität Münster), M. ROBECKI, and J. BETTMER

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 12, 30-34

A reversed phase HPLC method for the simultaneous determination of organic ionic lead and mercury species is described, based on derivatization with methyl thioglycolate and analysis on a 5  $\mu$ m Hypersil ODS column (25 cm x 4 mm i.d.) methanol and citric acid buffer as mobile phase, and UV detection at 235 nm. The HPLC conditions were optimized. For enrichment of the compounds from water samples, the complexed organo-metallic species were preconcentrated on a Nucleosil C18 pre-column (30 mm x 4 mm i.d.). Recoveries of 70-80 per cent were achieved. The detection limit was 270-800 ng per litre. **Germany**

95-0190

**Aluminium detection in water with chromazurol and a surfactant mixture as part of non-stop, continuous flow analysis.**

I. I. SAVRANSKII (I. H. Shevchenko University, Kiev), R. A. RODIONOVA, and O. Y. NADZHALOVA

*Journal of Water Chemistry and Technol. Logy*, 1994, **15**, No 1, 18-21

A method for the detection of aluminium in water containing chromazurol and a mixture of surfactants (cetylpyridinium chloride and OLEF) using flow injection analysis and spectrophotometry is described. The buffer was an acetate mixture (pH 6). Hydroxylamine sulphate and 1:10 phenanthroline were used to eliminate the influence of copper(II) and iron(III). Optical density was measured at 620 nm. The method was rapid (50 samples per hr) and had a detection limit of 0.05  $\mu$ g per ml for aluminium. **Ukraine**

95-0191

**Preconcentration and voltammetric measurement of silver(I) with a carbon paste electrode modified with 2,9-dichloro-1,10-phenanthroline-surfactant.**

S. S. HUANG (Hunan University, Changsha), Z. C. CHEN, B. L. LI, H. G. LIN, and R. Q. YE

*Analyst*, 1994, **119**, No 8, 1859-1862

The behaviour of a carbon paste electrode modified with 2,9-dichloro-1,10-phenanthroline was studied when used for the preconcentration and voltammetric determination of silver(I) in wastewater. A surfactant was also incorporated into the carbon paste mixture. The electrode was able to bind silver ions chemically and gave a better voltammetric response for silver than did ordinary carbon paste electrodes. The preparation and renewal of modified electrodes and optimal analytical conditions are discussed. Gold(I) ions interfered in the determination of silver(I) ions while many alkali and alkaline earth metal ions and common anions did not interfere. Fifty-fold excesses of iron(III), copper(II) and lead(II) were tolerated. The electrode response was characterized with respect to paste composition, preconcentration time, silver(I) concentration and reproducibility. The method showed good linearity for 0.8 nmol per litre (0.5 nmol per litre silver(I) in nitric acid medium. Results for waste water samples were in good agreement with those obtained by a spectrophotometric method. **China**

95-0192

**Colorimetric method for the determination of vanadium with tannic acid in water and oils.**

I. BOSCH-SERRA (Valencia University, Burjassot) and G. BOSCH-MORELL

*Fresenius Journal of Analytical Chemistry*, 1994, **349**, No 10, 117-121

Tannic acid was used as a complexing reagent to form a coloured reaction product with vanadium. The reaction product was quantitatively extracted into 1-pentanol in the presence of a cationic surfactant (4 per cent cetylpyridinium chloride). The absorbance of the vanadium complex was measured at 490 nm against a blank reagent in the same way. This method was successfully applied to the determination of trace levels (10 ng per ml) of vanadium in natural waters without any preconcentration step. It was also used to determine vanadium below 1 mg per kg in edible oils and petroleum products. The reaction of tannic acid with vanadium required a reaction time of 5 minutes at room temperature to obtain equilibrium. Once extracted into organic solvent the absorbance of the vanadium complex was stable for at least 20 h. Iron(III) produced the most significant interference at levels above 0.05 mg per 100 ml and its removal was necessary by use of a preconcentration step for vanadium (liquid-liquid extraction with 8-hydroxyquinoline in 1-hexanol). **Spain**

95-0193

**Speciation of chromium in the waste water from a tannery.**

K. STEIN (Technische Universität, Chemnitz-Zellwitz) and G. SCHWEDT

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 12, 38-41

Chromium(VI) is more toxic than chromium(III). Chromium(III) cannot pass through cell membranes because of its stable hydrate. An analytical strategy was developed and applied to 3 tannery wastewater samples. The chromate reduction capacity and chromium(III) content of the samples were determined. Chromium species were separated by ion exchange, liquid-liquid extraction, ultrafiltration and dialysis. The chromium(VI) species were unstable in both wastewater samples. Most of the chromium(III) was associated with macromolecular particles. Most of the chromium could be coprecipitated with ferric hydroxide and aluminium hydroxide. **Germany**

95-0194

**Catalytic spectrofluorimetric determination of copper using aerial oxidation of ascorbic acid in the presence of o-phenylenediamine.**

S. KAWAKUBO (Yamaguchi University, Kofu), H. KATO, and M. IWATSUKI

*Analyst*, 1994, **119**, No 7, 1119-1123

A method for the determination of copper in water is described, based on the copper-catalysed aerial oxidation of L-ascorbic acid to dehydroascorbic acid and fluorimetric detection at 425 nm (excitation at 350 nm) of quinoxaline derivatives formed by the successive reaction of dehydroascorbic acid with o-phenylenediamine. The fluorescence intensity was proportional to the square of the reaction time in the initial reaction at pH 6.9 and 2.50. The calibration plot was linear for 0.8  $\mu$ g copper per litre. The relative standard deviation was 5 per cent for determinations of 4  $\mu$ g copper per litre. The detection limit was 0.06  $\mu$ g per litre. Interference from molybdenum(V), chromium(VI), and vanadium(V) was tolerable at 1-10  $\mu$ g per litre. Interference from iron(III) up to 500  $\mu$ g per litre and iron(II) up to 200  $\mu$ g

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per litre was eliminated by the addition of sodium nitrite. The method was applied to the determination of copper in river and rain water samples. **Japan**

**95-0195**

**Voltammetry of copper diethyldithiocarbamate in toluene and toluene-based solvents: development of a solvent extraction-stripping method for the determination of copper using microdisk electrodes.**

J. H. SANTOS (Flinders University, Bundoora, Vic.), A. M. BOND, J. MOCÁK, and I. J. CARDWELL

*Analytical Chemistry*, 1994, **66**, No 11, 1925-1930

As a prelude to the achievement of analytically ideal voltammetry in toluene, voltammetric studies of the oxidation and reduction of copper diethyldithiocarbamate (copper(dedtc)) were undertaken in toluene containing Hex4NC104 or Hex4NPF6 as electrolyte using conventional and micro-sized platinum disk electrodes. This system gave reversible and well behaved electrochemical responses in other nonaqueous solvents. In toluene these electrochemical processes were also reversible despite the insolubility of the charged products. Near ideal steady state reversible voltammetry was possible at ambient temperatures using 10  $\mu$ m diameter disk microelectrodes and the addition of at least 0.05 M Hex4NC104 or Hex4NPF6, 50 per cent (v/v) acetone, or 40 per cent (v/v) acetonitrile. The theoretically expected peak type response was obtained in pure toluene under conditions of cyclic voltammetry using a 1 mm diameter platinum disk working electrode, an electrolyte concentration of 1 M and a temperature of 50°C. However, these conditions were not attractive for the development of analytical methods for copper determination. The microelectrode measurements under steady state conditions were preferred in the analytical sense. Cathodic stripping voltammetry (CSV) was suitable for the determination of copper as the diethyldithiocarbamate complex, since adsorption of the copper(dedtc)<sub>2</sub> plus complex occurred on the electrode surface. Solvent extraction of aqueous copper(II) into toluene coupled with CSV at a microdisk electrode would provide a simple method for the sensitive determination of copper in water samples. **Australia**

**95-0196**

**Determination of zinc in seawater using flow injection analysis with fluorimetric detection**

J. L. NOWICKI (Moss Landing Marine Laboratories, Calif.), K. S. JOHNSON, K. H. COATE, V. A. FLEOD, and S. H. HILBERMAN

*Analytical Chemistry*, 1994, **66**, No 17, 2732-2738

A flow injection analysis (FIA) system is described for the determination of zinc in seawater. The system incorporated an on-line cation exchange column to separate zinc from interfering alkaline earth metals (calcium, magnesium, barium) and to concentrate zinc from seawater. The organic ligand para-tolyl-8-aminoquinoline (PTAQ) was used to form a fluorescent complex with zinc, the fluorescence being measured with a flow-through fluorometer. The fluorescence signal was linearly related to the zinc concentration. The detection limit was 0.1 nM for a 4-4 ml sample. The precision based on the replicate analysis of samples spiked with 4-3 nM zinc was plus/minus 6 per cent. The analysis time for a single sample was 6 minutes. Method validation was achieved using standard seawater reference samples (CASS-2 and NASS-2). Only cadmium interfered substantially at 10 times its normal seawater concentration. Cadmium interference was minimal in open ocean surface waters because the signal from the picomolar levels of this metal was below the detection limit of this system. **U.S.A.**

**95-0197**

**Development of an automated technique for the speciation of arsenic using flow injection hydride generation atomic absorption spectrometry (FI-HG-AAS).**

T. R. RUDE (Karlsruhe University) and H. PUCHERT

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 1/2, 44-48

An automated method for the determination of arsenic acid (arsenic(V)), arsenous acid (arsenic(III)), monomethylarsonic acid (MMAA) and dimethylarsinic acid (DMAA) was developed using flow injection hydride generation atomic absorption spectrometry. The behaviour of the different species in hydrochloric, nitric, oxalic, acetic and tartaric acid was evaluated. A 4 step scheme is proposed: 4 mol hydrochloric acid per litre for the determination of arsenic(III); 0.165 mol hydrochloric acid per litre with potassium permanganate for the determination of DMAA and MMAA; 0.025 mol hydrochloric acid per litre with potassium permanganate of composed signals of MMAA and DMAA by different sensitivity; and 0.85 mol tartaric acid per litre with potassium permanganate for the determination of all 4 species. The detection limits for all 4 species were 0.2-0.5 ng per ml. There are 45 references. **Germany**

**95-0198**

**Determination of total arsenic and speciation of arsenobetaine in marine fish by means of reaction-headspace gas chromatography utilizing flame-ionization detection and element specific spectrometric detection.**

U. BALLEN (Staatliches Veterinäruntersuchungsamt für Fische und Fischwaren Cuxhaven), R. KRUSE, and H. A. RUSSEL

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 1/2, 54-61

Marine organisms are characterized by a relatively high arsenic content (1-10  $\mu$ g per g). The biosynthesis and toxicology of arsenobetaine, an organic form of arsenic, are outlined. A method for the determination of arsenobetaine and total arsenic in marine food is proposed. Total arsenic was determined by hydride following mineralization. Arsenobetaine was determined by extraction with water/methanol/chloroform, mineralization with nitric, perchloric and sulphuric acid, and headspace GC using flame ionization detection. Arsenobetaine recoveries of greater than 96 per cent were achieved. **Germany**

**95-0199**

**Speciation of cadmium in seawater - a direct voltammetric approach.**

U. HILLMERS (Alfred Wegener Institute for Polar and Marine Research, Bremerhaven)

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 1/2, 62-67

Seawater samples from the Atlantic ocean were analysed for cadmium using differential pulse anodic stripping voltammetry. The working electrode was made of glassy carbon material, the reference electrode was silver/silver chloride and the auxiliary electrode was platinum/potassium chloride. The enrichment time was 20-50 minutes and the voltage range was minus 0.9 V to minus 0.1 V. Two different cadmium species could be differentiated in the voltammograms. These were identified by UV irradiation experiments as an inorganic and an organic form. Atlantic ocean surface seawater normally contained 2-4 ng organically complexed cadmium per kg and no detectable inorganic cadmium. However, in some areas up to 14 ng inorganic cadmium per kg was observed. Inorganic cadmium

levels increased with depth. The biogeochemical cycle of cadmium in the ocean is discussed. There are 30 references. (Germany)

#### 95-0200

##### **Determination of antimony in waste water with Chromazurol S by beta-correction spectrophotometry.**

H. W. GAO (Huabei Environmental Monitoring Centre, Anhui) and P. F. ZHANG

*Analyst*, 1994, **119**, No 9, 2109-2111

The determination of trace amounts of antimony in wastewater was studied by beta-correction spectrophotometry using the reaction between antimony and Chromazurol S in pH 5.6 buffer solution. Beer's law was obeyed across the concentration range 0.1 mg antimony(III) per litre. The relative standard deviation was less than 4.1 per cent and the recovery was 92.109 per cent. The detection limit was 0.009 mg per litre. (China)

#### 95-0201

##### **Determination of barium in waters by tungsten coil electrothermal atomic absorption spectrometry.**

M. M. SILVA (Instituto de Física e Química de São Carlos), R. B. SILVA, E. J. KRUG, J. A. NOBRECA and H. BERNDT  
*Journal of Analytical Atomic Spectrometry*, 1994, **9**, No 8, 861-865

The suitability of 150 W tungsten coils as atomizers for the determination of barium in natural waters by electrothermal atomic absorption spectrometry (ETAAS) was evaluated. The thermal treatment of the analytical sample was carried out in 41 seconds, a 10 µl sample volume being used for barium determinations in waters in the 10-250 ppb range with good precision (relative standard deviation less than 5 per cent). A combination of hydrogen and argon was used as purge gas. The tungsten coil had a lifetime of up to 400 firings in 0.014 M nitric acid. Tolerance levels up to 8000 ng for potassium, 6000 ng for sodium, 1000 ng for magnesium, 10 ng for calcium and 10 ng for strontium were found for the atomization of 200 pg of barium. Larger amounts of calcium were prevented from interfering by the addition of EDTA. The detection limit for barium was 2 pg and the characteristic mass was 7.6 pg. (International)

#### 95-0202

##### **Micro-determination of gold using N-cyanoacetylacetaldehyde hydrazone.**

M. A. KABIL (Mansoura University), S. F. GHAZY, M. A. MOSTAFA and A. A. EL-ASMY

*Presentes Journal of Analytical Chemistry*, 1994, **349**, No 1011, 775-776

A procedure is proposed for the flotation and micro-determination of gold(III) using N-cyanoacetylacetaldehyde hydrazone (CyAH). CyAH formed a blue 1:1 complex with gold(III) at pH = 7. Absorbance of the gold(III)-CyAH system increased with increasing reagent concentration due to the shift of the equilibrium in favour of the complex. Maximal absorbance was obtained with equimolar amounts of gold(III) and CyAH. A 10-fold molar excess of CyAH was used to ensure complete reaction. Maximal absorbance was obtained after 7 minutes instantaneously by adding 3.3 mmol phosphoric acid or by heating to 55°C. Beer's law was obeyed for the gold(III) concentration range 1-30 ppm with a molar absorptivity of 3000 litres per mol cm at 550 nm. Many common anions and cations were tolerated in amounts 200 times that of gold(III). Platinum(IV) and palladium(III) interferences, even at low levels, were eliminated by adding trans-1,2-diaminocyclohexane. N,N,N',N'-tetraacetic acid (DCTA). Maximal floatability (100 per cent) of gold(III) was

achieved in the pH range 4-6.5. Flotation was enhanced by raising the temperature to 55°C. Results for the analysis of gold(III) in spiked seawater and river water samples were in good agreement with those obtained using atomic absorption spectrometry (AAS). Recoveries were near quantitative and the relative standard deviation was 1.42 per cent. (Egypt)

#### 95-0203

##### **A novel derivatization procedure for inorganic mercury(II) for HPLC analysis.**

D. FABBRI (Università di Bologna) and C. TROMBINI  
*Chromatographia*, 1994, **39**, No 3/4, 246-248

Stirring a 2-phase system of aqueous mercury(II) chloride (minimal concentration examined 2 ng per litre), containing sodium hydroxide and sodium chloride, and a dichloromethane solution of phenylacetylene for 90 minutes afforded diphenylethynylmercury quantitatively. This mercury derivative was directly extracted into the organic phase and effectively analysed by high performance liquid chromatography (HPLC) with UV detection. The calibration curve was linear over 3 orders of magnitude (0.02-80 mg per litre) and the detection limit was 0.1 ng mercury. To verify the applicability of this methodology to real samples a set of preliminary tests on the effect of potential interfering ions (copper(II), zinc(II), cadmium(II) and lead(II)) were carried out. These metals at 20 mg per litre did not affect the determination of mercury at a concentration of 0.2 mg per litre. However the presence of cysteine led under the formation of diphenylethynylmercury but this interference was overcome in more alkaline conditions. Data are presented for the analysis of mercury in natural waters (tap, lake and seawater). Lake water and particularly seawater required a slight modification of the work up procedure which consisted of acidifying with acetic acid (before extracting with dichloromethane) until the white precipitate of alkaline earth hydroxide dissolved. (Italy)

#### 95-0204

##### **Mercury-cycling in surface waters and in the atmosphere - species analysis for the investigation of transformation and transport properties of mercury.**

R. F. BINGHAUS (GKSS Research Centre, Geesthacht), H. HINDEMANN and R. D. WILKIN

*Presentes Journal of Analytical Chemistry*, 1994, **350**, No 1/2, 31-39

A method for the determination of mercury in solid and liquid samples using HPLC coupled to an atomic fluorescence spectrometry (AFS) is described. Sediment samples were incubated with citrate buffer, extracted with chloroform, and the diethylenetriamine complexes were removed with sodium nitrite solution. The organomercurials were back extracted with sodium thiosulphate solution and ammonium acetate. Water samples were acidified with hydrochloric acid, extracted with toluene, and back extracted with thiosulphate. The samples were analysed on a 5 µm Chromospher RP 18 column (20 cm x 3 mm i.d.) with a guard column (10 mm x 3 mm i.d.) a mobile phase of methanol and water (30/70), 2 mercaptoethanol and ammonium acetate. Total gaseous mercury was collected on gold coated glass balls and analysed by cold vapour atomic fluorescence spectrometry. These methods were used to analyse water and sediment from the Elbe river and air samples from Germany and Ireland. The Elbe river showed distinct hot spots of mercury and methyl mercury contamination close to the mouths of the Mulde river and Saale river. (Germany)

95-0205

## Flow injection potentiometric and voltammetric stripping analysis using a dialysis membrane covered mercury film electrode.

J. H. ALDSTADT (Ohio University, Athens), D. E. KING and H. D. DEWALD

*Analyst*, 1994, **119**, No 8, 1813-1818

A cellulose triacetate (CTA) dialysis membrane mercury film electrode (CM-MFE) was incorporated into a continuous flow system for the determination of lead in environmental and clinical samples. Thus, commercially available CTA dialysis membranes were secured to a glassy carbon disk electrode using a Plexiglas cap in a wall jet flow cell. Flow injection square wave anodic stripping voltammetry (ASV) and flow injection potentiometric stripping analysis (FI-PSA) were used to determine low ppb levels of lead in tap, river and seawater. FI-PSA was also effective for urine and whole blood sample matrices. Lead was determined in certified whole blood samples (188 ppb) with a precision of 10.6 per cent and a accuracy of 4.91 per cent. The analysis time was 6 minute per sample. The advantage of the CM-MFE over other polymer modified electrodes was that a polymer casting step (difficult to perform reproducibly) was not involved. The FI-PSA technique offered the potential for field portable applications. There are 45 references. (U.S.A.)

95-0206

## An on-line method for the determination of lead and lead isotope ratios in fresh and saline waters by inductively coupled plasma mass spectrometry.

I. HALL (National Research Council of Canada, Ottawa, Ont.), J. W. H. JAM and I. W. MCLAREN

*Spectrochimica Acta*, 1994, **49B**, No 7, 637-647

A previously reported ICP-MS method for the determination of lead and other trace elements in seawater was examined for its suitability in the on-line determination of lead isotope ratios (lead-206/lead-207 and lead-207/lead-208). The method was based on the separation of trace elements of interest from seawater by adsorption on a small column of silica-immobilized 8-hydroxyquinoline, followed by their removal with a small volume of acid for introduction to the ICP-MS instrument. A detection limit of 0.9 ng per litre for total lead (5 ml sample) was achieved. Precision of isotope ratio data was 0.2-0.3 per cent (relative standard deviation) at a lead concentration of 1 ng per litre, and was better than 2 per cent at lead concentrations between 10-40 ng per litre in seawater (certified reference materials (CRM). For each of the CRM (SLRS-2, NASS-3 and NASS-4) examined, measured precision was very close to the limit predicted by counting statistics. One limitation of this method was its inability to provide useful information for lead-204, the abundance of which is too low for measurement by this method for which only a few seconds of data acquisition time was available because of the transient nature of the signal. (Canada)

95-0207

## Examination of the different procedural steps in the determination of organotin compounds in water samples.

K. BERGMANN (Philipps Universität Marburg), U. ROHR and B. NEIDHART

*Fresenius Journal of Analytical Chemistry*, 1994, **349**, No 12, 815-819

With a view to the development of a standardized analytical method for the identification and determination of the different organotin compounds at concentrations in the range 5-500 ng organotin species (OTS) per litre water, the different steps in the DIN (Deutsche

Industrie Norm) procedure were examined using a gas chromatography/mass spectrometry (GC-MS) system. The DIN-procedure involves extraction of the organotin compounds from acidified samples by tropolone/hexane, derivatization with the Grignard reagent n-pentylmagnesium bromide, purification by solid phase extraction and determination after solvent evaporation. The stability of the analytes in the samples, the extraction and chromatographic purification steps, and a possible evaporation of organotin compounds were studied using GC-MS. The proposed DIN-procedure was a reliable method when the different parameters in the procedural steps were strictly observed. Extraction yields were improved (monoalkyltin species included) by the use of N,N-diethyldithiocarbamate as the complexing agent. Only losses of butyltin compounds occurred during the solvent evaporation step. (Germany)

95-0208

## Organotins: their analysis and assessment in the Elbe river system, northern Germany.

R. D. WILKIN (GKSS Research Center, Geesthacht), J. KUBALLA and U. JANTZEN

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 1/2, 77-84

Methods for the determination of organotins in sediment samples are reviewed. A new method based on derivatization with sodium tetraethylborate and GC-AAS is compared with the standard extraction method using hexane and tropolone. A table of the detection limits obtained using different chromatographic methods and detection methods is included. Hamburg harbour sediments were analysed by GC-AAS with derivatization with sodium tetraethylborate or extraction with hexane/tropolone. Three patterns were observed: very high concentrations of tributyltin compared with other organotins; higher concentrations of tributyltin than tetraethyltin; similar or higher concentrations of tetraethyltin than tributyltin. These different patterns were explained by different sources and the degradation of organotin compounds. All organotins were found in a transect of the Elbe river. The highest concentrations of the tributyl and tetraethyltin were found in a tributary of the Elbe river, the Mulde river, with concentrations of 2.7 and 14 mg per kg, respectively. Organotin distributions were influenced by ship paints and industrial emissions. There are 46 references. (Germany)

95-0209

## Automated determination of weakly acidic and basic pollutants in surface water by on-line electro dialysis sample treatment and column liquid chromatography.

M. G. M. GROENEWEGH (Free University, Amsterdam), N. C. van de MERBEL, J. SLOBODNIK, H. LINGEMAN and C. A. I. BRINKMAN

*Analyst*, 1994, **119**, No 8, 1753-1758

The application of electro dialysis sample treatment (E-DIST) to the selective enrichment of weak acids and bases from surface waters prior to their analysis by liquid chromatography (LC) is described. The influence of several system parameters such as electrical potential, donor flow rate, sample volume and pore size of the separation membrane, on the enrichment efficiency and on the removal of interfering matrix components was evaluated. The effect of a pH shift taking place in the sample during electro dialysis was also studied. Aniline was used as a model compound (weak base) for these studies. The completely automated procedure allowed a 7-10 fold selective enrichment of several anilines and several chlorinated phenoxy acids from surface water (750 ul) within 25 minutes by applying a donor flow rate of 50 ul per minute and a potential of 7.5-10 Volts. A

separation membrane with a 3.5 kDa pore size eliminated matrix effects. Using LC with UV detection, detection limits for all compounds studied were in the range 0.5-5.0 µg per litre. **Netherlands**

#### 95-0210

##### **Amperometric determination of *N*-nitrosamines in aqueous solution at an electrode coated with a ruthenium-based inorganic polymer.**

W. GORSKI (Miami University, Oxford, Ohio) and J. A. COX, *Analytical Chemistry*, 1994, **66**, No 17, 2771-2774.

A method was developed for the direct electrochemical determination of *N*-nitrosamines employing oxidation of these analytes while avoiding the interference from dissolved oxygen. Deaeration of solutions was not necessary. Thus, the diffusion-limited electrochemical oxidation of *N*-nitrosamines in an aqueous pH 7.5 buffer was achieved at a glassy carbon electrode coated with a film of mixed valency ruthenium oxides that were stabilized by cyano cross-links,  $\text{MVRu}(\text{CN})$ . The process was carried out at a potential of 1.08 V versus silver/silver chloride in 3 M sodium chloride where ruthenium(IV) was the electron transfer mediator in the film. The  $\text{MVRu}(\text{CN})$  electrode was used in a potentiostatic amperometric detection as part of a flow injection analysis (FIA) high performance liquid chromatography (HPLC) system for the separation and determination of several nitrosamines. Using HPLC with a C18 column, the detection limit for *N*-nitrosodipropylamine (NDPA) was 10 nM and a calibration curve was linear in the range 50 nM-1 µM. The relative standard deviation (RSD) of 5 replicate samples of 0.8 µM NDPA was 2 per cent. This method eliminated the need for an analytical derivatization step in the analysis of these compounds. **U.S.A.**

#### 95-0211

##### **On-line trace enrichment - column liquid chromatography of polar pollutants in surface water using bifunctional membrane-based extraction-disk cartridges.**

F. H. R. van der Wal (Free University, Amsterdam), F. R. BROUWER, H. LINGEMAN, and L. A. T. BRINKMAN, *Chromatographia*, 1994, **39**, No 3/4, 239-245.

Cation exchange was used in combination with C18 modified silica membrane extraction disks to achieve the simultaneous enrichment of acidic, basic and neutral compounds in surface water samples. The on-line trace enrichment device consisted of a specially constructed holder containing both C18 and cation exchange disks capable of holding up to 25 disks (0.5 mm thickness and 4.6 mm diameter). The behaviour of this bifunctional membrane extraction disk cartridge was studied with particular reference to the influence of temperature during analyte desorption. Desorption of the cartridge was at elevated temperature using reversed phase gradient elution. Detection was performed with a diode array UV absorbance detector. Before trace enrichment of 20 ml of surface water (pH 3), calcium ions were removed from the sample by precipitation with oxalic acid. The total analytical procedure was validated by measuring its linearity and precision. The calibration graphs were linear in the range 0.5-50 µg per litre and the relative standard deviation was better than 10 per cent in most cases. The detection limits for the 13 test compounds ranged from 0.5 µg per litre (Bentazone, metolazon, chloridazon, simazine, atrazine and diuron) to 2 µg per litre (dinoseb). **Netherlands**

#### 95-0212

##### **Trace analysis of organics in aqueous samples by concentration in plastic tubing and multiplex gas chromatography.**

M. ZHANG (Xinjiang Institute of Technology, Urumqi) and J. B. PHILLIPS,

*Chromatographia*, 1994, **39**, No 5/6, 294-298.

Multiplex gas chromatography was combined with a simple sampling scheme to provide a method for the trace analysis of organics in aqueous samples. The sampling method involved trapping organic substances from a water sample on the inside wall of an uncoated polyethylene capillary as the sample was pumped through it using a stream of nitrogen gas and subsequent heating in a chromatographic oven to release the trapped organic substances. Released substances were transported through a thermal desorption modulator to a chromatographic column. Concentrations of sample components were modulated as they entered the column by pulsing the temperature of the modulator. Detection limits below 1 ppb were possible using a flame ionization detector. **China**

#### 95-0213

##### **Identification of halogenated compounds in chlorinated seawater and drinking water produced offshore using *n*-pentane extraction and open-loop stripping technique.**

N. K. KRISTIANSEN (National Institute of Public Health, Oslo), M. TROSHAUG, K. T. AUNE, and C. BECHER,

*Environmental Science & Technology*, 1994, **28**, No 9, 1669-1673.

Volatile halogenated compounds suspected of being present in a wide concentration range of chlorinated sea water and in drinking water produced on oil platforms were identified. The performance of *n*-pentane extraction and that of the open-loop stripping technique were also compared. The halogenated compounds were determined by gas chromatography combined with electron capture detection and mass spectrometry. A large number of halogen substituted aliphatic and aromatic compounds were identified in both chlorinated sea water and drinking water. It was important to destroy residual active halogen in samples when using *n*-pentane for the extraction of chlorination by-product. **Norway**

#### 95-0214

##### **Comparison of European and American techniques for the analysis of volatile organic compounds in environmental matrices.**

T. C. VOICE (Michigan State University, East Lansing) and B. KOHL,

*Journal of Chromatographic Science*, 1994, **32**, No 8, 306-311.

A comparison was made between the U.S. EPA purge and trap or dynamic headspace gas chromatographic methods for the analysis of volatile organic compounds (VOC) and the European static headspace gas chromatographic method. Both methods were compared for use with different environmental matrices. There were substantial differences between the techniques, each having its own advantages and disadvantages. There was, however, no technical basis for universally favouring one approach over the other. For soil sample headspace analysis with equilibration at 95°C, was superior to purge and trap at low VOC levels. However, purge and trap was preferred at very high VOC levels. Data are presented on the use of headspace analysis for different aqueous matrix types with different sample preparation procedures. **U.S.A.**

95-0215

## Development of a new method for direct measurement of pCO<sub>2</sub> in natural waters

G. CHIFF (Heidelberg University) and J. HUMBIRGER

*Limnology and Oceanography* 1994, 39, No 4, 976-981

Carbon dioxide was separated from a water sample by diffusion through a thin silicon rubber tube, which retained ions present in the water. The carbon dioxide was equilibrated in deionized water flowing inside the tube and the conductivity of the solution measured in a conductivity flow cell. Two hundred and fifty-five standard samples with carbon dioxide concentrations ranging from 0.01 to 1.00 mM per litre gave a mean carbon dioxide exchange ratio of 0.95 across the tubing with a standard deviation of plus or minus 0.04. For 40 standard samples with carbon dioxide in the concentration range 1.4 to 10.0  $\mu$ M per litre the carbon dioxide exchange ratio was 0.94 with a standard deviation of plus or minus 0.9. The detection limit of this method was 0.6  $\mu$ M per litre. **Germany**

95-0216

## Retention and separation of some organic water pollutants with unloaded and tri-n-octylamine loaded polyester-based polyurethane foams.

M. S. EL-SHAHAWI (United Arab Emirates University, Al-Ain, U.A.E.)

The removal of some phenols from high volume water samples using polyester-polyurethane foam, either unloaded or loaded with tri-n-octylamine, was investigated. The extraction mechanism involved whether solvent extraction, cation chelation, anion exchange, or other mechanisms, was also examined. In static mode, the loaded foams showed a better extraction affinity towards the phenols than unloaded foams. The parameters affecting the efficiency of retention by the foam were examined using a batch technique. In column mode, a recovery and retention efficiency of up to 98.5 per cent was achieved. The mechanism may also be solvent extraction. There are 31 references. **United Arab Emirates**

95-0217

## Continuous liquid-liquid extraction with on-line monitoring for the determination of anionic surfactants in waters

M. AGUADO (Complutense University), A. RIOS, and M.

V. ALCARAZ

*Analyst* 1994, 119, No 9, 2097-2100

A method for the on-line preconcentration and monitoring of anionic surfactants in water is described. An organic plug (approximately 200  $\mu$ l) containing the reagent was placed and retained at the detection point whilst a large volume of sample (aqueous phase) was passed through it. The enrichment of the organic phase with the analyte was monitored. The chemical system involved the formation of an ion pair between the anionic surfactant sodium dodecyl sulphate (SDS) and the quaternary cation methylene blue which was extracted into chloroform where the absorbance was measured at 650 nm. The determination limit was 20 ng per ml. The relative standard deviation was 6.7 per cent. The sample throughput was 20 per h. The analytical method was applied to synthetic samples of SDS and to water samples. **Spain**

95-0218

## Optimization of instrumental parameters for flow injection analysis-thermospray tandem mass spectrometry.

R. B. GLEERDINK (RIZA, Lelystad), P. G. M. KIENHUIS, and L.

A. T. BRINKMAN

*Chromatographia* 1994, 39, No 5/6, 311-319

The optimization of the electron multiplier voltage and the resolution of the first and second mass analysers in a thermospray tandem mass spectrometer system to optimize signal to noise ratios was studied. Samples containing 8-chlorophenoxy-carboxylic acid herbicides and bentazone were used with a flow injection analysis system to determine signal to noise ratios at various electron multiplier voltages. A voltage of 2500 V improved signal to noise ratios up to 13 fold compared with the usual 1700 V. Further improvements were achieved by applying additional resolution voltages of 3.4 V to the first and second mass analysers. **Netherlands**

95-0219

## Determination of HCHs, PCBs and DDT in brain tissues of marine mammals of different age.

S. MOSSNER (Universitat Ilm), T. BARUDIO, T. S. SPRAKER,

G. ANTONIUS, G. EARLY, J. R. GERACI, P. R. BECKER,

and K. BALT SCHMIDT

*European Journal of Analytical Chemistry* 1994, 349, No 10/11, 708-716

High resolution capillary gas chromatography with electron capture detection (HRGC-ECD) was used to determine concentrations of PCB and chlorinated pesticides in brain tissue of marine mammals of different age and regional origin. Tissues of dead northern fur seal pups from Alaska and an adult female common dolphin stranded on the coast of Massachusetts were examined. The results showed clearly that alpha-hexachloro-cyclohexane (alpha-HCH) was dominant in all brain tissues (90-203 ng per g extractable lipids) compared with other tissues like liver or blubber (45-61 ng per g extractable lipids). The alpha-HCH in a brain tissue was dominated by the plus enantiomer where as in other tissues both plus- and minus enantiomers contributed. HCH isomers showed equivalent levels to DDT and PCB in brain tissues whereas the latter 2 groups were more abundant in liver tissue and blubber. Principal component analysis (PCA) and similarity index were used to make statements about the preferential accumulation of PCB congeners in the various tissues. **International**

95-0220

## On-line trace-level enrichment gas chromatography of triazine herbicides, organophosphorus pesticides, and organosulphur compounds from drinking and surface waters.

S. PICO (Free University, Amsterdam), A. T. HOUTER, J. J.

VRIJES, and L. A. T. BRINKMAN

*Analyst* 1994, 119, No 9, 2025-2031

A method for the determination of triazines, organophosphorus pesticides, and sulphur containing compounds in tap water samples by on-line solid phase extraction gas chromatography (SPE-GC) is described. The system consisted of a 10 x 2 mm i.d. precolumn packed with 10  $\mu$ m PLRP-S styrene-divinylbenzene copolymer, a silica cartridge to remove water present in the ethyl acetate used as the desorption solvent, and GC on a 0.34  $\mu$ m DB-1 column (15 m x 0.32 mm i.d.) operated with temperature programming from 75 to 300°C, helium as carrier gas, with flame ionization detection (FID), nitrogen-phosphorus detection (NPD) or flame photometric detection (FPD). Recoveries of more than 72 per cent were achieved. The detection limits were less than 0.1  $\mu$ g per litre with all detectors. The

NPD and FPD had better selectivity and sensitivity than the FID. Water samples from the Rhine river, Thames river, Nitra river and Ertis river were analysed. Netherlands

95-0221

**Headspace solid-phase microextraction versus purge and trap for the determination of substituted benzene compounds in water**

B. MacGILLIVRAY (Waterloo University, Ont.) J. PAWELCZYK, P. FOWLER and C. SAGARA

*Journal of Chromatographic Science*, 1994, 32, No 8, 317-322  
Headspace solid-phase microextraction (SPME) was compared with purge and trap (P&T) for the analysis of benzene, toluene, ethylbenzene and the xylenes (BTEX) in water. Conditions for headspace SPME were optimized (temperature, pH and salt addition) using a three factor, two level statistical design. Best sensitivity was achieved at ambient temperature with sodium chloride saturation. Effects of pH were insignificant for BTEX recoveries. Multiple samples ranging from 4-140 ppb were analysed by both methods. Results for both methods consistently correlated. The cycle time was reduced, making this technique suitable for fieldwork. Canada

95-0222

**Tri- and tetrafluorobenzoates as nonreactive tracers in soil and groundwater**

C. E. BENSON (New Mexico Institute of Mining and Technology, Socorro) and R. S. BOWMAN  
*Soil Science Society of America Journal*, 1994, 58, No 4, 1123-1129

Batch soil equilibration tests on 4 previously untested trifluorobenzoate (TFBA) and 2 previously untested tetrafluorobenzoate (TFBA) isomers in 3 different soils showed that although there was no sorption of weaker fluorobenzoates (FBA), all compounds were chemically stable for at least 70 d. An algorithm is presented for estimating potential sorption of an FBA isomer to a soil from its  $pK_a$  and organic carbon content. The average soil organic carbon sorption coefficient estimated for protonated FBA species was 8.2 (0.1) litres per kg plus or minus 6300 litres per kg for a total FBA solution concentration of 5 mg per litre. Breakthrough curves for TFBA and FBA isomers obtained by 6 d laboratory column sorption tests were indistinguishable from those of bromide under saturated and unsaturated conditions. Mass recoveries of 101-104 percent in all column tests provided no evidence of degradation or sorption. All 16 ring substituted FBA could be used together with bromide as multiple nonreactive soil and groundwater tracers. U.S.A.

95-0223

**Phenylurea herbicides (uronis), dinocap, dinoseb, benomyl, carbendazim and metamitron in waters 1994.**

*H.M. Stationery Office, London: Methods for the Examination of Water and Associated Materials*, 1994, 64pp  
A selection of methods for the determination of the most common examples of phenylurea herbicides is presented, the method of choice being dependent on the equipment available in the user's laboratory. The methods include reverse phase and normal phase HPLC and GLC with NPD detection. A note outlining the use of the thermospray LC/MS method for determination of urons is also included and alternative extraction procedures comprise solid phase and liquid-liquid extraction methods. In addition to the 5 herbicides named in the title, carbetamide may also be determined with certain of the

methods described. In general linear responses are obtained at concentrations below 2 µg per litre. U.K.

95-0224

**Determination of aldicarb and other N-methyl carbamates in waters 1994.**

*H.M. Stationery Office, London: Methods for the Examination of Water and Associated Materials*, 1994, 28pp  
Two methods for the determination of aldicarb and related N-methyl carbamates are described. The first involves reverse phase HPLC with post-column derivatization and fluorescence detection; a liquid chromatography-mass spectrometry (LC/MS) method is also included as a confirmatory technique. The target compounds include aldicarb and its sulfoxide and sulphone derivatives, together with carbaryl, carbosulfan, ethioncarb, methiocarb, methomyl, oxamyl and propoxur. In addition an outline of an alternative procedure for aldicarb and its sulfoxide and sulphone derivatives is presented based on oxidation and gas chromatography using an N-selective detector, the results being expressed as sulphone. These and some other compounds may also be determined directly by GLC analysis. U.K.

95-0225

**Determination of fenamiphos and folpet in water by time-domain differentiation of high-performance liquid chromatographic peaks**

P. PARRILLA (Almeria University), M. MARTINEZ GALLERA, J. L. MARTINEZ VIDAL and A. G. ERENICH  
*Analyst*, 1994, 119, No 10, 2231-2236

Samples containing fenamiphos and folpet were filtered through a 0.45 µm filter, pre-concentrated on a Sep-Pak C18 cartridge, eluted and injected onto a high-performance liquid chromatography column. The composition of the mobile phase was optimized by an automated sequential procedure. A map of signal intensity in the wavelength-time domain demonstrated the incomplete resolution of the 2 substances. This was effected by taking the first derivative of the absorbance with respect to time using commercial software and additional programs. The smoothing and differentiation of the chromatographic peaks was done by the Savitzky-Golay method. Good calibration graphs were obtained for the first derivatives. Recoveries from ultrapure, drinking, sea and ground waters were 92.5-87.3, 74.2 and 89.7 percent respectively for fenamiphos and 98.2-85.9, 50.5 and 93.8 percent respectively for folpet. Full details are provided. There are 33 references. Spain

95-0226

**On-line isotachopheretic sample pretreatment in ultratrace determination of paraquat and diquat in water by capillary zone electrophoresis**

D. KANIANSKY (Comenius University, Bratislava), I. IVANYI and J. LONČSKA  
*Analytical Chemistry*, 1994, 66, No 11, 1817-1824

The herbicides paraquat and diquat were determined at nanomole per litre concentrations in tap and surface waters using a combination of capillary zone electrophoresis (CZE) with on-line isotachopheretic (ITP) sample pretreatment. A photometric absorbance detector was used, operating at 310 nm wavelength. The ITP stage provided a high enrichment factor for the analytes by combining high concentrating power with removal of matrix constituents. Thus a sample volume of 90 µl was measured giving a herbicide detection limit of 1 nmol per litre. Adsorption losses of the pesticides on the walls of the sample containers were the principal source of analyte



## MONITORING AND ANALYSIS

cal errors. These were minimized by spiking the samples with diethylenetriamine. There are 56 references. **International**

### 95-0227

#### The effect of chlorinated water on the pesticides prometryn and terbutryn.

A. P. FAIRHEAD

*Journal of Institution of Water and Environmental Management* 1994, 8, No 4, 399-401

The degradation of the pesticides prometryn and terbutryn by chlorinated (0.8 mg chlorine per litre) water is reported. Reaction was pH dependent with a half life of between 4 and 10 minutes between pH 7.5 and 9.0. Terbutryn was not detectable after 10 minutes reaction. The reaction occurred by oxidation to form a sulphoxide. Similar degradation of EPTC and methibuzin is reported. **U.K.**

### 95-0228

#### Analysis of binary mixtures of 3,3',4,4'-tetrachlorobiphenyl and 2,3,7,8-tetrachlorodibenzofuran by derivative synchronous fluorescence spectrometry in organized media.

J. J. SANTANA RODRIGUEZ (Las Palmas University) / Z. SOSA FERRERA, J. HERNANDEZ GARCIA, and A. J. HERMEJO MARTIN LAZARO

*Analyst* 1994, 119, No 10, 2241-2246

The second derivative spectra of binary mixtures of 3,3',4,4'-tetrachlorobiphenyl (TCB) and 2,3,7,8-tetrachlorodibenzofuran (TCDF) dissolved in aqueous ethanol in the presence of polyoxyethylene (10)lauryl ether (POLE) were obtained by synchronous fluorescence. POLE was chosen from several surfactants, giving the greatest enhancement of fluorescence. Both monochromators were scanned with a constant 48 nm between them. The fluorescence intensities of the derivative signals were directly related to the concentration of each compound. Analyses were also carried out in UV-sterilized sea water. Simultaneous determination by conventional fluorescence was impossible because of strong peak overlap. The proposed method resolved the peaks and gave high recoveries with limits of detection of 5.4 and 2.7 ng per ml for TCB and TCDF, respectively. There are 43 references. **Spain**

### 95-0229

#### Determination of strontium-90 in water and urine samples using ion chromatography.

J. CORRIE (Loughborough University of Technology) / P. WARWICK, R. C. CARPENTER, and R. T. MORRISON

*Analyst* 1994, 119, No 8, 1759-1764

A semi-automatic ion chromatography (IC) method was used to isolate the daughter isotope of strontium-90 in a form suitable to its subsequent measurement by beta counting. The method required yttrium-90 and strontium-90 to be in secular equilibrium prior to analysis, but the isolation of yttrium-90 rather than strontium-90 simplified the subsequent beta counting. Yttrium-90 was initially extracted from the sample solution, buffered to pH 5, using high capacity iminodiacetate chelating resin. At this pH transition metals, lanthanides and actinides were extracted by the resin before being transferred to a separator column for separation and elution as weak acid anionic complexes. Transition metals were eluted first by using pyridine 2,6-dicarboxylate eluent, then the lanthanides, actinides and yttrium-90 were eluted using an oxalate diglycolate effluent. The yttrium-90 containing fraction was collected and beta counted. Minimal sample preparation was required for the analysis of water samples but urine samples required pretreatment by oxalate copre-

cipitation to pre-concentrate the yttrium-90. The recoveries of strontium-90 for surface water, rain water and urine samples were, respectively, 91.7 (plus/minus 1.8) per cent, 91.9 (plus/minus 1.6) per cent and 90.0 (plus/minus 2.7) per cent. The minimal detectable activity using gas flow proportional counting was 8 mBq L<sup>-1</sup> K.

### 95-0230

#### Ozone water demand test.

Y. RICHARD (Degremont Le Pecq, France)

*Ozone Science & Engineering* 1994, 16, No 4, 355-365

The practices of laboratories concerned with determining the ozone demand of water have been evaluated, and issued as 2 recommended methods by the Quality Assurance Committee of the European African Group of the International Ozone Association. These are described, and the methods and equipment detailed. One introduces the ozone into the water under test as a saturated solution, the other directly as a gas. The first method ensures very rapid mixing, such that the initial ozone demand can be determined within about 30 seconds; it does, however, dilute the test water. The second avoids the dilution factor problem, but mixing takes 1-1.5 minutes. This delay complicates the second ozone demand value; the time taken for the ozone to decline to half its initial value - is the mixing time, could constitute a significant fraction of it. Sampling at intervals is required to determine the half value point, and any further having values that may be helpful, the intervals are judged after an initial exploratory screening exercise. Ozone determination is by the indigo method outlined. Ways of presenting the analytical data are discussed, and the value of noting other characteristics of the water under test, such as pH, temperature, alkalinity, DOC, UV absorbance, turbidity, nitrite, ferrous iron, manganese, and bromide, is considered. **France**

### 95-0231

#### Optical fibre sensor for biological oxygen demand

C. PREININGER (Karl-Franzens University, Graz) / T. KLIMANT and O. S. WOITTEIS

*Analytical Chemistry* 1994, 66, No 11, 1841-1846

A fibre optic microbial sensor for the determination of BOD is described. The fibre tip sensing membrane consisted of layers of an oxygen sensitive fluorescent material, *Trachosporon cutaneum* microorganisms immobilized in poly(vinylalcohol), and a substrate permeable poly(urethane) membrane to retain the yeast cells. The layers were placed in this sequence on an optically transparent gas impermeable polyester support. Tris(4'-diphenyl-1,10-phenanthroline)ruthenium(II) perchlorate was used as the oxygen indicator. The fluorescent signal of the sensor was affected by the thickness of the coating layers, the cell density of the yeast, and the rate of substrate through the flow through cell. Typical response times were 5-10 minutes and the linear dynamic range was from 0 to 110 mg per litre BOD when a glucose/glutamate BOD standard was used. BOD values obtained with the biosensor were in good agreement with those determined by the conventional BOD5 methods. Sensor life times varied from ~ 30 d. Reconditioning was a problem; all sensors needing recalibrating after reconditioning. Advantages of this fibre optic biosensor included rapid estimation of BOD, the fact that optical oxygen sensors do not consume oxygen, and the possibility of performing *in situ* monitoring. **Austria**

95-0232

**The use of caesium-137 to measure dispersion from discharge pipelines at nuclear sites in the UK.**

A. J. BAXTER (Ministry of Agriculture, Fisheries and Food (Lowestoft)) and W. C. CAMPBELL

*Water, Maritime and Energy*, 1994, 106, No 3, 281-288

Procedures used by the Ministry of Agriculture, Fisheries and Food (MAC) for measuring the dispersions from discharge pipelines at nuclear sites in the U.K. are described. Concentrations of caesium-137 in seawater near nuclear sites had been monitored by MAC since 1962. A method is presented for estimating the initial dispersion in the immediate area of a nuclear site by calculating the concentration of caesium-137 in seawater for a unit rate of introduction in liquid effluent. The method is illustrated with several examples. Normal radioactivity concentrations of caesium-137 in seawater are summarized. U.K.

## WATER TREATMENT

See also Abstracts 95-0019, 95-0035, 95-0036.

95-0233

**Mine's a Cornish nasty**

C. WILLIAMS

*Water Engineer*, 1994, No 574, 12-13

The National Rivers Authority has built a pilot treatment plant as a long-term solution to the Wheal Jane tin mine incident in Cornwall, 1992 when more than 10 million gallons of polluted water escaped into Falmouth bay. The temporary treatment involved dosing with lime, a final polishing lagoon before discharge. The new treatment plant consists of 3 parallel schemes, and includes lime dosing, anoxic pond, anoxic limestone drain and a series of aerobic cells. The first two cells use reed beds to remove iron hydroxide plus anaerobic cells based on cattle manure, and sawdust to remove cadmium, zinc, copper, some iron and sulphite as insoluble metal sulphides. Finally, manganese is removed by algae in a rock filter. U.K.

95-0234

**Biological processes at Saints Hill water-treatment plant, Kent**

F. P. BOUQUINE (Dynamac Ltd.), M. GINSLEY, J. I. CHAPMAN, H. KERAI, J. G. GREEN, R. J. RAP, S. STELS and C. CALMARD

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 4, 379-392

Biological processes involved in the removal of iron, manganese and ammonium are summarized. Geological and hydrogeological conditions at Saints Hill treatment works (Kent) are briefly described and results of pilot plant trials presented. Design considerations for a full-scale 3 stage filtration process are described and results of commissioning trials presented. Filter wash failures were initially high. Operating costs of treatment are compared with a conventional physical/chemical treatment plant. Critical conditions for biological removal of iron and manganese were identified and included pH, redox potential and temperature. Additionally, for ammonium removal, alkalinity and dissolved oxygen were critical. Advantages of a third filtration stage included additional treatment capacity for unproven sources and a reduced requirement for instrumentation. U.K.

95-0235

**Plant by the lake: a model of innovation.**

I. LISK

*Water Engineering & Management*, 1994, 141, No 8, 18-20 and 22

Carbondale city's new 8 mgd water works used Clariflo clarifiers with rim-supported foundations to increase seismic stability. Novel features included a single helical flow, weir outlet and ribbon flow, clearwell baffling to extend retention time. An aeration process was chosen for trihalomethane (THM) control. The formation of THM was first encouraged before they were removed. U.S.A.

95-0236

**A nitrogen success story**

J. E. WILSON (Rust Environment and Infrastructure, Schaumburg, Ill.), D. W. PICKARD and R. E. BLIZZARD

*Water Environment & Technology*, 1994, 6, No 9, 70-74

The operation of the Hooker's Point advanced waste water treatment works at Tampa, Fla., the world's largest nitrogen removal unit, is presented. Presently treating a flow of 70 mgd, but being expanded to cope with 96 mgd by the Autumn of 1995, it uses a 2 stage nitrification process, followed by denitrification in deep bed filters. Targets for its effluent include a 90 per cent reduction of the 5 d BOD, suspended solids, and total nitrogen from their influent levels of, respectively, about 250, 200 and 30 mg per litre. Local industrial and brewery effluents account for about 45 per cent of the BOD, though only 8 per cent of the flow. The layout of the works as originally built and as later modified is shown. Most of the waste activated sludge is now digested anaerobically, rather than aerobically. Gravity waste activated sludge thickeners have been replaced by dissolved air flotation units and belt thickeners, and the solids retention time has been reduced to avoid the foaming believed to be caused by the presence of *Nocardia*. The progress of the decline of the target factors after various stages of treatment is shown, as is the time the liquid spends in each. An outline of costs per unit volume of water treated is included. U.S.A.

95-0237

**Evaluation of a water purification system referring to mutagenicity**

Y. MACHIDA (Ministry of Health and Welfare, Tokyo), Y. KUROSAWA and Y. HISAMATSU

*Aqua*, 1994, 43, No 5, 52-261

The mutagenicity values of simulated raw waters treated in a 4 m<sup>3</sup> per d plant by coagulation, sedimentation, and granular activated carbon (GAC) filtration were evaluated by the Ames assay using *Salmonella typhimurium* His TA98. In some cases, ozonation was included before GAC filtration. The raw waters were made from dechlorinated tap water mixed with 0.45 µm filtered domestic sewage effluent. The mutagenicity of this effluent was also examined after chlorination or ozonation. Both disinfectants increased the mutagenicity of the raw waters, the products of ozonation became mutagenic on chlorination. However, ozonation combined with GAC filtration removed mutagen precursors, with biological GAC filtration being less effective than non biological GAC. This indicated that a prolonged use of GAC in biological mode was undesirable. Chemical water quality parameters did not always match the results of the mutagenicity test. The procedure for the Ames test is outlined. Japan.

## WATER TREATMENT

95-0238

**Re-use of backwash water at drinking water treatment works.**  
J. W. WOUTERS (DHV Water BV), J. van der VELDE, and R. J. N. WILLEMSE.

*H2O*, 1994, 27, No 20, 606-609 (in Dutch, English summary, p. 593).

Netherlands water treatment works were calculated to use about 3.5 per cent of their product water for backwashing. While those deriving their water from the surface can return it to the inflow, where it will receive the total treatment offered by the works, this is not feasible for groundwater, which normally receives no more treatment than filtration and aeration. As groundwater constitutes two thirds of the nation's drinking water, the recovery and re-use of backwash water from these sources is important for the country's total requirement. Techniques for its treatment (coagulation, sedimentation, rapid sand filtration, disinfection) and delivery to the drinking water storage reservoir at the works are outlined; parameters required to design an efficient and economical works are listed, and the value of simulation techniques emphasized. (English translation, 145 pounds sterling valid for 1995). **Netherlands**

95-0239

**Chemistry of arsenic removal during coagulation and Fe-Mn oxidation.**

M. EDWARDS (Colorado University, Boulder).

*Journal of American Water Works Association*, 1994, 86, No 9, 64-78.

Arsenic geochemistry, occurrence, and treatment options are reviewed. In natural waters, soluble arsenic only occurs in the arsenate (arsenic V) and arsenite (arsenic III) oxidation states. Iron and manganese exert a strong influence on environmental arsenic concentrations. Approximately 30 per cent of medium to large utilities may have more than 2 µg arsenic per litre in the raw water. Problems were most frequent in the western United States and in smaller systems relying upon groundwater sources. Activated aluminium, iron oxide coated sand, green sand, reverse osmosis and electro dialysis were possible technologies for arsenic removal which were not yet proven for low level arsenic removal at full scale plants. Coagulation with metal salts, softening and iron-manganese treatment were existing processes capable of removing significant concentrations of arsenic. Batch coagulation experiments and arsenic adsorption modelling of iron-manganese removal processes showed that arsenic removal efficiency depended on the removal of soluble arsenic and of the resulting particulates. Previous research results are also reviewed. Coagulant dosage, pH and initial arsenic concentration affected arsenic V and arsenic III removal. Coagulation with alum and ferric coagulants was effective in removing arsenic V below pH 7.5. Iron was more effective than alum in removing arsenic III and arsenic V above pH 7.5. There are 63 references. **U.S.A.**

95-0240

**Choice of the optimization criterion of water treatment processes in the periodic action units.**

I. V. BOIKO (Kiev Polytechnic Institute), N. V. BRAZHENKO, and A. S. KOROLEV.

*Journal of Water Chemistry and Technology*, 1993, 15, No 12, 15-17.

A comparative analysis of the optimization of water treatment by ion exchange, filtration and adsorption on activated carbon, using mathematical models of each process, is presented. The optimization criterion had a distinctly expressed extremum, whose co-ordinates depended on the conditions of the process implementation. With an

increase in the concentration of impurities the optimal time of the layer operation decreased, corresponding to a shift of the extremum to the left. Changes in regeneration retention time did not affect the optimal time of the layer operation but led to changes in the optimization criterion. The optimal operation time of the layer was smaller than the time to which breakthrough of impurities can be observed. **Ukraine**

95-0241

**Add-on treatment of the Dniester river tap water using a household filter.**

B. M. KATS (Scientific Research Institute of Physics, Odessa), T. V. STRIKALENKO, R. M. DLUBOVSKII, E. V. POPOVA, and N. V. GURSKAYA.

*Journal of Water Chemistry and Technology*, 1993, 15, No 12, 28-31.

Water quality in the Dniester river is contaminated with phenols, petroleum products, halogen-containing compounds and heavy metals and failed to meet requirements for drinking water supplies. The feasibility of using low capacity domestic filters for the add-on purification of water was investigated. Each filter consisted of the following layers: chemisorption fibre, a sulphocation exchanger, activated charcoal, and activated charcoal impregnated with silver. The filter was effective in removing heavy metals, chloro-organic pesticides, petroleum products, synthetic surfactants and halogen-containing compounds but the service life of the filter was limited to 6 months by the efficiency of retention of phenols in the filter. **Ukraine**

95-0242

**Where on-line sensors are headed**

S. A. WORTENDYKE (Capital Controls Company, Inc., Colmar, Pa.).

*Water Engineering & Management*, 1994, 141, No 8, 23-24.

On-line monitors for the water and wastewater industry developed from the need to automate standard laboratory tests. Outside factors such as regulatory pressures or software advances speeded their development. A trend in instrumentation was to minimize waste products. Laboratory development which could be applied to on-line sensors in the future included solid state electrodes and fibre optics. **U.S.A.**

95-0243

**It's not easy being Green lake.**

W. A. ZATLER (Camp Dresser and McKee Inc., Walnut Creek, Calif.), P. A. DANIEL, A. de STEIGL, and D. G. WONG.

*Water Environment & Technology*, 1994, 6, No 9, 64-68.

Proposals for the reduction of phosphorus in Green lake, Wash., a popular recreational area whose value was regularly curtailed by severe algal blooms, are outlined as a group, before attention is directed to one of them in particular. The general plan involved eliminating the sources of the phosphorus, what was already in the sediment could be immobilized by the addition of aluminium sulphate, stormwater inflows could be diverted, the algae could be harvested, and bio-manipulation could reduce the presence of waterfowl (a major phosphorus source) and carp. In addition, the lake's waters should be re-cycled through a treatment works, which would gradually lower their phosphorus content to no more than 30 µg per litre, at which point algal growth had become a problem. Hitherto drinking water from the Seattle supply had been used as a diluent to bring the lake's natural content down to this level, but rising demands on this supply had made a continuance of the practice unfeasible.

The proposed treatment works was given a target of producing a water containing not more than 10 µg phosphorus per litre from a lake water of 50-150 µg per litre. Alternative technologies were evaluated and costed, at bench scales. The one chosen, principally on grounds of filtration efficiency and least use of backwash water, used a roughing filter and a polishing filter, with half of the dose of coagulant (alum or ferric chloride) and a cationic polymer added before the roughing filter, and the other half between it and the polishing filter. U.S.A.

## 95-0244

**Point-of-use/point-of-entry treatment of drinking water**

B. W. LYKINS (U.S. EPA, Cincinnati, Ohio), J. A. GOODRICH, R. M. CLARK, and J. HARRISON

*Water Supply*, 1994, 12, No 1/2, SS 41-SS 45

Point-of-use/point-of-entry (POU/POE) devices for controlling contaminants in drinking water are discussed. Granular activated carbon (GAC), membranes, ion exchange, distillation, aeration and disinfection could feature in such units. GAC-based devices were tested on groundwater containing trace organic compounds of agricultural origin and another water contaminated with trichloroethylene. The effectiveness of the units varied in the volumes of water they treated before exhaustion. Most met their specification. The use of POU/POE was feasible for a water utility with many small sources or decentralized treatment facilities supplying 25 or fewer households in any group. U.S.A.

## 95-0245

**Drinking water treatment in the 1990s**

E. C. KRUTHOF (KIWA NV, Research and Consultancy, Nieuwegein) and E. C. SCHIPPER

*Water Supply*, 1994, 12, No 1/2, SS 51-SS 54

Modern waterworks needed upgrading so that their output met present and likely future quality standards. This was true whatever the source of raw water since even underground waters were often polluted by volatile organohalogen pesticides and nitrates. Nitrification by biological treatment was increasing. Air stripping and activated carbon (GAC) filtration were often employed to remove volatile compounds. GAC filtration also eliminated taste odour and pesticides. UV irradiation after GAC filtration was a frequently employed method of disinfection. The treatment of surface waters was more complex, arising from disinfection by products, contaminants from bacterial metabolism, biologically hard and softening compounds and salts. Treatment processes based on ozonation, GAC filtration, advanced oxidation and membrane filtration were likely for these in the future. Examples of such processes are provided. Netherlands

## 95-0246

**Investigations into the flocculation mechanisms of small algal cells**

H. BERNHARDT (Wohnbachtalsperrenverband, Siegburg) and J. CLASEN

*Appl.*, 1994, 43, No 5, 222-232

The flocculation of the alga *Synechocystis minima* was investigated in a stirred laboratory flocculator connected at its base to a filter column of 0.37-0.50 mm quartz gravel. This was isolated by a plug which was removed after the algae had aggregated. The intensity of stirring depended on the coagulant, being least for polyelectrolytes. The algae were microscopically examined after destabilization. Electrophoretic mobility was measured throughout the experiments. Flocculation followed the principle of adsorption-coagulation with

charge neutralization when cationic polyelectrolytes or positively charged aluminium hydroxo complexes were the flocculants. pH was also influential. Maximal filterability resulted at the point of charge neutralization where the algal cells formed aggregates. Fourteen photomicrographs illustrate the effect of experimental conditions on the algal cells. There are 46 references. Germany

## 95-0247

**Enhanced coagulation for arsenic removal**

R. C. CHEN (Metropolitan Water District of Southern California, La Verne), S. LIANG, H. C. WANG, and M. D. BEUTLER

*Journal of American Water Works Association*, 1994, 86, No 9, 79-90

Arsenic removals by coagulation treatment under varying conditions were evaluated in bench, pilot, and demonstration scale tests at facilities of the Metropolitan Water District of Southern California. Two source waters were used. Alum and ferric chloride were the coagulants and a cationic polymer was used as a coagulant aid. Ferric chloride was not pH dependent and was more effective than alum. Alum was pH dependent with highest arsenic removals achieved below pH 7.0. Bench scale tests achieved better arsenic removal percentages than pilot or demonstration tests when alum was used. U.S.A.

## 95-0248

**Assessing roughing filtration design variables**

M. R. COLLINS (New Hampshire University, Durham), J. O. COLLETT, C. M. WESTERSUND, and D. B. PARIS

*Water Supply*, 1994, 12, No 1/2, SS 59-SS 60

The variables affecting the performance of gravel roughing filters used for the pretreatment of turbid waters was examined in a downflow filter of 90 cm depth, 20 cm diameter, with orthogonal experimental arrays. Turbidity was provided by kaolinite clay (K-clay) at 1000 mg per litre at pH 7 and ionic strength 0.003 M. The algae *Scenedesmus* were introduced in some cases. The influence of filter depth, gravel size, and hydraulic loading was confirmed; the removal of K-clay was determined by these variables as listed in descending order of importance. Algal removal was affected most by hydraulic loading rate, then media size and filter depth. The design variables exerted a linear effect on performance, with the exception of gravel size in the treatment of algae. Sedimentation was the principal transport process for particulate removal in these filters. The extent of removal depended on the nature and size of the particles, the presence of algae, and the natural water constituents. U.S.A.

## 95-0249\*

**Treatment and utilization of sludge from water works**

B. LAMBERTH (Institut of Sanitary Engineering, Water Quality and Solid Waste Management, Stuttgart) and U. ROFF

*HYDROTOP 94 Colloque Miravetres (Lain, Marseille, France)*, Volume 2, 1994, 427-434 (in English)

Some of the problems presented by the disposal of waterworks sludge are reviewed in view of the situation obtaining in Germany where the annual rate of production is of the order of 100 000 tonnes dry weight. Various types of sludge are involved, depending on the process concerned (coagulation of surface waters, iron/manganese removal from groundwater, or water softening plants). Several methods of sludge dewatering are considered, together with their advantages and disadvantages and the probable outcome in terms of the solids content of the dewatered product. Typical results from differ-

## WATER TREATMENT

ent works employing plate filter presses for sludge dewatering gave cake solids contents ranging from 43 per cent to 63 per cent depending on the initial solids content prior to dewatering. Various disposal options are outlined from incorporation into cement production to discharge via the public sewer or disposal to landfill. **Germany**

### 95-0250

#### **Integral approach of W 1-residuals.**

A. GRAVPELAND (Amsterdam Water Supply, Maarssen), S. G. J. HEIJMAN and H. M. M. KOPPERS  
*Water Supply*, 1994, 12, No 1/2, SS 34, SS 36

Reduction, recycling and utilization of residues from water treatment were encouraged in the Netherlands by the government with the assistance of the Water Works Association. Coagulation, softening and granular activated carbon filtration could be optimized to reduce the use of consumable materials; recycling was possible and residues had value in sewage treatment or agriculture. The recycling of backwash water was usually feasible. There was no obvious value in the brine from membrane filtration processes and this was discharged in an environmentally least harmful way. The application of optimization and recycling at the Amsterdam Waterworks is described. **Netherlands**

### 95-0251

#### **Two years experience with sulphur/limestone denitrification of drinking water at a full-scale works.**

I. SCHÖNENBERG, KEGEL (KIWANN), J. P. van der HOEK, B. J. MIDNARENDIS and C. A. van BENSEKOM  
*H<sub>2</sub>O*, 1994, 27, No 20, 610-615 (in Dutch, English summary, p. 593 and 598)

Rising concentrations of nitrate in the groundwater source of a drinking water treatment works in Eastern Gelderland, The Netherlands, necessitated the introduction of nitrate removal if the works was to meet the EC limit of 50 mg per litre. The groundwater contained 80-100 mg per litre. The scheme adopted was a 4 stage process: vacuum was first applied to remove nitrogen and oxygen gas, the water then passing over a bed of limestone and sulphur granules, seeded with *Thiobacillus denitrificans*. It was then re-aerated via cascade, and finally infiltrated through soil for the removal of bacteria and accumulated biomass. Although there was evidence of some nitrate breakthrough from the denitrification bed, the works virtually always produced water with 25 mg per litre or less of nitrate. At this level, it was unnecessary to treat the whole flow, as blending with that portion of it that was not denitrified would allow the product water to meet its standard. (English translation, 725 pounds sterling valid for 1995). **Netherlands**

### 95-0252

#### **Occurrence of pesticides in natural waters and removal during drinking-water treatment processes.**

J. P. DUQUEL (Eyonnaise des Eaux, Dumez, Le Pecq), I. BERNAZI, AL and A. BRUCHEF  
*Water Supply*, 1994, 12, No 1, 2, SS 11, 1, SS 11, 5

The presence of pesticides in natural and drinking waters in France and present methods of removing them are discussed. Two national studies since 1987 had investigated groundwater and rivers for 32-44 common pesticides. A wide range of substances was detected, with atrazine and simazine being the most common. Pesticide removal could be effected by a combination of ozone with hydrogen peroxide or UV irradiation followed by granular activated carbon filtration at 10-30 mg per litre. Ultrafiltration on hollow fibre membranes com-

bined with powdered activated carbon had proved effective. A 45-99 per cent removal of various pesticides had been demonstrated in a nanofiltration pilot plant, indicating that this treatment alone was insufficient. There was a need for better process control techniques to monitor the removal of pesticides. **France**

### 95-0253

#### **GAC adsorption of intermittently loaded pesticides.**

Y. MATSUI (Hokkaido University, Sapporo), T. KAMEI, F. KAWASE, V. L. SNOEYINK and N. TAMBO  
*Journal of American Water Works Association*, 1994, 86, No 9, 91-102

The removal efficiency of intermittently applied pesticides (simazine, napropamid, bentazon, asulam and hymexazol) on an activated carbon adsorber preloaded with humic substances was evaluated using the rapid small scale column test. Pesticides with a higher water solubility had a lower removal efficiency. Preloading with background organic matter (BOM) decreased removal efficiency. Pesticide removal followed first order kinetics. A linear driving force expression was used to model the adsorption kinetics. It was possible to predict the removal efficiency of a pesticide without experiment adsorption data provided the amount of BOM adsorbed was known. There are 30 references. **Netherlands**

### 95-0254

#### **Investigation of equilibrium adsorption of chloroorganic compounds on granulated porous carbons in water treatment.**

V. N. SMAGIN (Water Reclamation Institute, Moscow), E. A. LUKASHIN and I. A. KAVITKA  
*Journal of Water Chemistry and Technology*, 1993, 15, No 12, 8-14

River and lake waters often contain chloro-organic compounds as a result of the application of chloro-organic pesticides in the catchment and the discharge of insufficiently treated industrial wastewaters containing chloro-organic solvents. Chloroorganics can be removed from water by adsorption on activated carbons. The adsorption of chloroform, trichloroethylene and tetrachloride carbon on activated carbon (KAD iodide, BAU and AG 3) and sulphocarbons (LS, SU, m) was studied as a function of chloro-organic compound concentration, pH, temperature and granulometric composition of SU, m. Adsorption of chloroform on SU, m deviated from the Henry isotherm at concentrations greater than 600 µg per litre. Granulation composition of SU, m did not affect adsorption capacity when purifying water containing low concentrations of chloroform (less than 500 µg per litre). With higher concentrations (greater than 12 mg per litre) greater efficiency was obtained with finer fractions of SU, m. Adsorption was unaffected by pH in the range 5-8.5. Chloroform adsorption on SU, m increased with increasing temperature in the range 10-30°C. **Russia**

### 95-0255

#### **Performance-based bid specifications for activated carbons.**

B. THOMAS (North American Inc., Atlanta, Ga.)  
*Public Works*, 1994, 125, No 10, 95 and 130

The use of performance-based bid specifications to produce a desired level of performance of water treatment works that would also reduce long term costs is examined. Bid specifications were used to evaluate activated carbons being used to adsorb odour-producing organic compounds at Arizona's water treatment works. The methodology for establishing performance-based bid specifications for municipalities using powdered activated carbon and for calculating dose equivalent factors is described. The results of a test programme



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Dune filtered water was treated by slow sand filtration without disinfection: strict bacteriological monitoring was necessary. Direct surface water treatment had breakpoint and post chlorination. The former would be replaced by ozonation and the latter would be omitted or UV irradiation undertaken in combination with GAC filtration. **Netherlands**

95-0262

### Byproducts of the aqueous chlorination of purines and pyrimidines

M. S. YOUNG (MITA Environmental Inc., Watertown, Mass.) and P. C. UDEIN

*Environmental Science & Technology*, 1994, 28, No 9, 1755-1758. The possibility of the formation of stable byproducts of environmental concern through the interaction of aqueous chlorine with purines and pyrimidines during the chlorination of drinking water was examined. The reaction products were determined using several gas chromatographic methods employing electron capture and nitrogen/phosphorus detectors. The results were confirmed by gas chromatography-mass spectrometry. Only low yields of haloacetonitriles were obtained, though numerous other organic byproducts including cyano compounds, haloaldehydes and haloacetic acids were identified. Two of the pyrimidines produced high yields of chlorinated aldehydes. Reaction pathways are suggested. **U.S.A.**

95-0263

### H<sub>2</sub>O enters the ozone

M. MONROE

*Contract Journal*, 1994, No 5997, 20-21

Coloured raw water, common in Aberdeen and surrounding areas, was currently treated by slow sand filtration, pH correction with lime and chlorination. The latter could give rise to excessive trihalomethane concentrations while only partially removing colour. It was planned to destroy colour by ozonation before the filters. Some details of the ozone generating plant are provided. **U.K.**

95-0264

### Growth of legionella and other heterotrophic bacteria in a circulating cooling water system exposed to ultraviolet irradiation

J. M. KUSNETSOV (National Public Health Institute, Kuopio), P. J. KESKITALO, H. E. AHONEN, A. T. TULKKELE, M. MIIJTINEN and P. J. MARTIKAINEN

*Journal of Applied Bacteriology*, 1994, 77, No 4, 461-466

The effects of UV irradiation on the occurrence and growth of legionellas and other heterotrophic bacteria in a circulating cooling water system were investigated. The system consisted of cold and warm water reservoirs. Water was circulated through a UV irradiation system in an open channel side stream once every 28 h. Immediately after the treatment, viable counts of legionellas and other heterotrophic bacteria were 0.12 per cent and 0.7-1.2 per cent, respectively, of those in the reservoir. Samples from the treated water incubated in the laboratory reached the counts in the reservoir water within 5 d, mostly through reactivation of cells damaged by UV light. **Finland**

95-0265

### Investigation of drinking water disinfection in a mock-up UV device

O. S. SAVILUK (A. V. Dumanski Institute of Colloid Chemistry and the Chemistry of Water, Kiev), N. G. POTAPCHENKO and V. V. ILIYASHENKO

*Journal of Water Chemistry and Technology*, 1993, 15, No 12, 41-47

The inactivation of *Escherichia coli*, *Streptococcus faecalis*, *Proteus vulgaris*, *Pseudomonas aeruginosa* and *Bacillus subtilis* in a pilot scale UV disinfection plant was studied. The relationships between radiation dose, flow speed and bacterial species were determined. The bacteria decreased in sensitivity to UV disinfection in the following order: *E. coli*, *P. vulgaris*, *P. aeruginosa*, *S. faecalis*, *B. subtilis*. Bacterial spores were the most resistant to disinfection and at a flow rate of 100 ml per h only 99 per cent of them die. **Ukraine**

95-0266

### Predicting the effects of resin cleaning on the performance of a deep-bed condensate polisher

G. L. FOUTCH (Oklahoma State University, Stillwater), S. PONDEGLIA and D. J. MORGAN

*Ultrapure Water*, 1994, 11, No 6, 22 and 24-25

The accuracy of model predictions of breakthrough of sodium and chloride from a mixed bed ion exchanger was compared with actuality at a U.S. power station. The model was derived from the station's practice of removing the resin (1:1 monovalent ratio) every 3 weeks for ultrasonic cleaning, and returning it to the bed; it was assumed that it would then be thoroughly mixed, and would present a homogeneous profile for ion exchange throughout its depth. Using data on the concentration of sodium and chloride in the influent in relation to the total exchange capacity, and the 10-fold difference in the selectivity for the latter compared with the former, the probable rise with time of each in the effluent was calculated. The presence of other elements in the actual influent at the power station complicated the validation of the model's predictions for chloride, where breakthrough of a prescribed value occurred at day 80 instead of the predicted day 50, but was very close for sodium. **U.S.A.**

95-0267

### Water softening by granulated cation exchanger based on zirconium phosphate

I. M. SHARYGIN (Thermoxid, Research and Production Firm, Zarechny), S. I. BOROVKOV, A. I. MOISEYEV and V. M. GALKIN

*Journal of Water Chemistry and Technology*, 1993, 15, No 12, 37-40

Zirconium phosphate is a medium strength bifunctional cation exchanger with an exchange capacity in neutral media comparable to that of organic cation exchangers. Its use as a cation exchanger has been limited by the absence of an effective method for its production in the form of granules with good kinetic characteristics. Thermoxid 3A, a spherical form of mechanically strong granules, is produced by a sol-gel method. The use of Thermoxid 3A for removing hardness salts from water was investigated. Full softening was achieved after the passage of 1600 cv when a KU-2-8 organic sulphonation exchanger was used. The hydrogen and sodium forms of Thermoxid 3A had the same water softening abilities. **Russia**

95-0268

**Using silicates to lower lead levels in drinking water.***Public Works*, 1994, 125, No 10, 83-84

The evaluation of treatment strategies for reducing lead, iron and copper levels and removing colour from the soft, moderately alkaline water of York, N.H., is described. The water corroded the unlined cast iron pipe distribution of the town, a problem that had not been alleviated by a new treatment facility. Sodium silicate was chosen to lower levels of these metals in the system. The studies were carried out to evaluate the effectiveness of sodium silicate and to provide more information on sodium silicate corrosion inhibition. Alkalinity, pH, calcium, iron, lead and copper were monitored at 12 homes throughout the system. Sampling procedures and study results are discussed. **U.S.A.**

95-0269

**Standardizing an attack against lead.**

J. NEWMARK

*Water & Waste Treatment*, 1994, 37, No 9, 50

SK-1 assemblies for dosing of orthophosphoric acid at 6 Welsh Water water treatment works for the reduction of lead in water are described. Bulk acid and dosing apparatus are separately banded. Health and safety considerations are discussed. **U.K.**

95-0270

**Hydrogen peroxide: a potent force to destroy organics in wastewater.**J. PLANT, Solvay Interco, Houston, Tex., and M. JEFF, *Chemical Engineering*, 1994, 101, No 9, 11-16, 11-20

Traditional water treatment methods, such as phase transfer, biological treatment and thermal or catalytic oxidation, have their limitations. Chemical oxidation is often used where biological treatment is ineffective. Commercially used water treatment chemicals include chlorine, potassium permanganate, ozone and oxygen. Hydrogen peroxide is an 'all purpose' oxidant which can be applied directly or in conjunction with a catalyst in advanced oxidation processes. A simple way to generate hydroxyl radicals is by using a Fenton's Reagent system. Difficult organic pollutants such as phenolics, chlorinated solvents and benzene can be destroyed by treatment schemes combining hydrogen peroxide with ultraviolet light. Peroxide systems, which combine hydrogen peroxide with ozone, also produce hydroxyl radicals as the active species. **U.S.A.**

95-0271

**Sonochemical destruction of CFC-11 and CFC-113 in dilute aqueous solution.**

H. M. CHENG, Akron University, Ohio, and S. KURUP

*Environmental Science & Technology*, 1994, 28, No 9, 1619-1622

The use of ultrasonically driven chemistry, or sonochemistry, to destroy fluorotrichloromethane (CFC-11) and trifluorotrichloromethane (CFC-113) in dilute aqueous solutions was investigated. Solutions with an initial concentration of approximately 50 mg per litre of the CFC were exposed to 20 kHz ultrasound with a power per unit volume of either 4.6 W per ml in a batch reactor or 0.64 W per ml in a circulating reactor. Fairly rapid destruction of the CFC was achieved, with less than 5 per cent undergoing volatilization. Destruction rates were slightly higher at 50°C than at 10°C. The solution pH decreased with sonication, suggesting the acidic species as a final halogen acceptor. **U.S.A.**

95-0272

**Brackish water supply enhancing fresh water availability.**

D. WILLY, Leggett Brashears &amp; Graham Inc., Tampa, Fla., and R. H. BROTHERTON

*Public Works*, 1994, 125, No 10, 92-93

To overcome water shortages and water degradation problems, Dunedin municipality has been evaluating the development of a brackish groundwater supply that could be treated and used to supplement available fresh water in the long term. Zones of brackish water were being delineated for mixing with fresh water and treated by reverse osmosis to provide potable water. A new pumping strategy was developed to enable the brackish water to be accessed from the deeper well zones. The development and use of a computer model in the preparation of a well field management strategy for the city is described. The city would begin pumping water from the test well to the reverse osmosis facility in late 1994. **U.S.A.**

95-0273

**Separation properties of ultrafiltration polysulfonic membrane modified by oligomer bianchor surfactants**

E. I. DANIILENKO, A. V. Danilinski Institute of Colloid Chemistry and the Chemistry of Water, Kiev, M. I. BRYK, A. I. BURBAN, A. N. TROKHIMENKO, and I. P. SAIKOS

*Journal of Water Chemistry and Technology*, 1993, 15, No 12, 32-36

The influence of the modification of polyfiltration polysulphonic membranes by bianchor oligomer surfactants (BOS) of the anionic and cationic types on biomembrane separation of electrolytes was investigated. Bianchor oligomer surfactants contain 2 end ionogenic groups:  $\text{—(CH}_2\text{)}_n\text{—SO}_3\text{Na}$  and  $\text{—(CH}_2\text{)}_n\text{—NH}_3^+\text{Cl}$ , which, as the horizontal position of the molecules of the surfactants on the phase boundary during the adsorption at the nonpolar surface. Modification of the membranes by BOS led to a decrease of their permeability and an increase in polyethylene glycol retention. The changes in the separation properties of the membrane were related to the changes in the dissolved solution-membrane surface interactions. **Ukraine**

95-0274

**Optimal use of membrane processes in drinking water treatment**

G. ANSELMETTI, J. J. Le Corre, Dorez, Le Pecq, A. MANDRA, E. BAUDIN, and J. MATHIEU

*Water Supply*, 1994, 12, No 37, SS 1-1, SS 2-11

The role of membrane technology in water treatment is discussed. Clarification of surface and underground waters of low DOC content could be carried out by microfiltration (MF) with polypropylene midflow fibre membrane, or ultrafiltration (UF) with cellulose membranes, the latter being preferable because viruses were removed. Softening and organic matter removal was best achieved by nanofiltration (NF) on hard waters of slight turbidity. Low molecular weight UF was sufficient for coloured waters containing micropollutants. Surface waters with high organic matter concentrations were difficult to treat with membranes. For flows below 200 m<sup>3</sup> per h, oxidation, powdered activated carbon adsorption and UF on cellulose membrane were viable treatment combinations. Above 1000 m<sup>3</sup> per h, membranes were only viable for polishing. NF on this scale was much more expensive than conventional treatment or UF. Costs and other data are provided. **France**



## UNDERGROUND SERVICES

95-0275

### Response of oligotrophic biofilm bacteria in high-purity water systems to stepwise nutrient supplementation.

G. R. HUSTED (MicroAssays of Vermont Inc., Montpelier), A. A. RUTKOWSKI and A. COITURE.  
*Ultrapure Water*, 1994, 11, No 6, 43-50.

The correlation between microbial growths found in high purity low nutrient water distribution systems and levels of nutrients was examined in a series of controlled nutrient additions. Ample evidence already existed of the necessity for a minimal concentration of carbon, and of variations of the attached biomass reflecting changes in the TOC of the water, sometimes leading to detachment, and that the level of elements needed by the sessile oligotrophic organisms in question was frequently below the limit of detection of instruments. The effects of increasing the levels of various elements that might have been the limiting ones for growth were therefore explored; in particular, the response in terms of the production of extracellular polymeric substances, which facilitate adhesion, was noted. Most dietary supplements produced no effect whatever, indicating that even high purity water contained adequate concentrations, but some (for example potassium phosphate acetate, all at the ppt level) stimulated cell division, and in some cases changed cell shape. A minute augmentation of carbon might cause considerable extracellular release, such that the TOC levels were higher beyond the organisms than in advance of them. Considerable variations in microbial response were found, for which tentative explanations are proposed. The need for continuous TOC monitoring at as many sites as possible is emphasized, especially if the product for which the water is destined is carbon sensitive. U.S.A.

95-0276

### Demystifying water treatment.

D. HAIRSTON

*Chemical Engineering*, 1994, 101, No 9, 71 and 73.

Users of industrial water treatment chemicals required more precise data about the constituents in their water. Although it was expected that clients would become more discriminating about what products they used, consumption was not expected to decrease and there was a 1.1 per cent annual increase in the value of industrial demand for water treatment. Most new product development was aimed at chlorine elimination. Some applications could also use simpler water treatments. U.S.A.

95-0277

### Still waters run deep.

J. HODGSON

*Biotechnology*, 1994, 12, No 10, 983-984 and 986-987.

A review is presented of European, U.S. and, to a minor extent, Japanese official requirements for, and industrial practice in, the preparation of high purity water used in pharmaceuticals preparation or as water for injection. The review opens with distinguishing between purified water and water for injection, although similar chemical qualities are demanded of both; the level of pyrogens and the microbial count permitted for the latter are lower. Attention is then directed to the source waters used for their manufacture, especially to their lack of consistency seasonally if the municipal supplier from whom most manufacturers draw their water happens to use a surface one. Overcoming such variations requires either advance notice from the municipal authorities (especially if they change their water source) or very frequent monitoring by the manufacturer. Variations in input quality cause more problems than the actual quality, which can generally be planned for, albeit at a price. The

processes used to prepare purified water are left to the discretion of the producer, but a considerable degree of regulation exists as to which processes may be used in preparing water for injection, a rare case of regulation by technique rather than by end product quality. Distillation is everywhere permitted; reverse osmosis is in some countries but not others. Manufacturers tend to work on the 'Safety First' principle, for example by using 'Water for Injection' quality water in their processes when this is not strictly necessary. The danger of microbial growth through on a membrane is thought to outweigh the cost benefit of reverse osmosis over distillation, whose higher energy costs do not, at least in the U.S.A., amount to much. The use of heated stainless steel pipes to distribute prepared water to points of use, relying on the heat to maintain sterile conditions, has changed somewhat with the practice of ozonation at ambient temperatures, permitting the use of other types of pipe which would have sagged when heated. Plastic pipe formulations are being developed constantly, but the risk of leaching from them has yet to be assessed. International

## UNDERGROUND SERVICES AND WATER USE

See also Abstracts 95-0001, 95-0018, 95-0037, 95-0039, 95-0085, 95-0092, 95-0152

95-0278

### Twentieth century water diving.

B. DUMBLETON

*Water & Waste Treatment*, 1994, 37, No 9, 28 and 31.

Identification of voids arising from leaking sewers using radar is reported. The magnitude of signals from dipole antennas in a vertical borehole array was compared during successive transmission and receipt of signals thus permitting a crude image of the conductivity of the ground. Design of antenna, source of signal, frequency of signal and effect of soil material are briefly considered. Applications of subsurface radar in Europe and the U.K. are briefly reported. U.K.

95-0279

### Pipe materials selection: a systematic approach.

P. J. de ROSA (WRc Engineering, Swindon) and J. F. McBRIDE.  
*Water Supply*, 1994, 12, No 1/2, S5-14, U.S5-14-5.

A flexible yet systematic method of selecting pipe materials is described which seeks to optimize costs and technical performance for all diameters. Developments in pipe line systems, components, joining, design theories and installation techniques are outlined. Aspects of selection procedures discussed include key objectives in pipe selection, extraneous factors influencing the decision, and the formulation of a strategy. Tables list pressure pipe materials for water supply applications and the principal advantages and limitations of 8 common pipe materials. A U.K. case study is presented. U.K.

95-0280

### Plastic alternatives.

*World Water and Environmental Engineering*, 1994, 17, No 7, 40.

Plastic pipes are suitable for submerged outfall pipelines installed by float and sink methods and can provide an alternative to concrete pipes for sewerage and drainage systems. The range of Weholite plastic pipes from KWH Pipe and their applications are described. These pipes were stiffer walled low pressure mono-plastics pipe.

with a spirally wound hollow-box sectioned wall with diameter of 20-110 mm. Advantages of Weholite pipes are discussed. However, the proper selection of bedding and backfill material and careful compaction in layers is critical in their installation and use. **U.K.**

**95-0281\***

**Energy recovery using hydropower equipment in drinking water supply systems.**

*Deutscher Verein des Gas- und Wasserfaches e.V. Eschborn*  
[Vt W. Merkblatt W 613, 1994, 31pp (in German)]

The ways in which useful energy (including electrical energy) can be generated or recovered during the operation of drinking water systems is reviewed in this booklet which sets out the principles and practical recommendations concerning the operation of such equipment, together with guidance with respect to electrical system protection and safety precautions, the relevant German and International standards and codes of practice governing the operation of such systems and the various types of hydraulic machinery and generators employed. **Germany**

**95-0282\***

**Dynamic pressure changes in water supply systems**

*Deutscher Verein des Gas- und Wasserfaches e.V. Eschborn*  
[Vt W. Merkblatt W 303, 1994, 30pp (in German)]

This advisory booklet presents guidance on the nature and characteristics of pressure surges in response to sudden changes in flow behaviour in hydraulic systems. It is a revised and updated version of the original booklet of the same topic issued in 1983 and presents the latest knowledge concerning the magnitude and methods of calculation of pressure surges and methods of countering them in a system for the storage and distribution of water supplies. The characteristics are especially important in the case of large network components of strategic importance where non-stationary processes such as pump failures or other flow discontinuities may have far reaching effects. A check list in tabular form is included summarizing the various types of damping devices available, their effectiveness, variability in service and maintenance requirements. **Germany**

**95-0283\***

**Extending the benefits of water distribution modelling in Severn Trent Water**

M. K. GWYNNE (Severn Trent Water Ltd, Birmingham) and I. E. BRAMMER

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille*  
*France* Volume 2, 1994, 103-110 (in English)

The nature of recent trends in the application of network modelling by Severn Trent Water is reviewed, leading to a description of the capabilities of the software provided by Stoner Associates Inc. which was introduced in 1991. The wide range of network parameters covered by this system, making it suitable both for strategic distribution and detailed network modelling applications, is discussed together with the characteristics rendering it easy to manipulate and control. Some examples of the way in which the new system has contributed to improvements in both the reliability and quality of supplies to customers within parts of the Severn Trent region are presented. Nitrate blending, chlorine residuals and replacement sources are all capable of representation in a manner which is readily intelligible to the user. In addition pressure changes and leakage control operations could be simulated with the model. **U.K.**

**95-0284\***

**Optimal real-time management for a drinking water supply network**

D. GIBLET (CEMAGREF, Gassin), A. OLIASSI and M. PIEROT

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille* Vol. 2, 1994, 113-121 (in French, English summary)

Faced with a considerable rise in demand for drinking water supplies during the 1980s, the Sarralbe water supply undertaking constructed a new waterworks for treating raw water abstracted from the Sarre while the security of supply was enhanced by the provision of cross connections between different reservoirs forming part of the network. In view of the increased complexity of the network structure there was a need for improved control systems, as a result of which the existing valves were automated and linked by telemetry to a central control point. The management of the system was then performed with the aid of a special type of model based on graphic programming, first used in France in 1989. The manner in which this type of programming is applied to the real time problems connected with the management of the distribution system is described in detail. The way in which the method was used to identify modifications to the network components to permit a worthwhile reduction in pumping costs is also outlined. **France**

**95-0285\***

**Management of a complex reactor: the distribution network for potable supplies**

Y. LEVÉYON (Université d'Aux-Damez La Préque), K. NEPIRIOT and O. WABE

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille* Vol. 2, 1994, 125-141 (in French, English summary)

The distribution system reviewed is a complex type of chemical reactor within which a variety of changes can be occurring simultaneously, affecting the chemical, physical, chemical and bacteriological characteristics of the supply. The nature of these changes and the manner in which they are influenced by a large selection of other factors, such as the materials and age of the pipework, are discussed and their significance for the production of a management programme which also considers hydraulic performance changes is outlined. Certain necessary facilities must be available for continuous monitoring from which predictions concerning the qualitative change can be made while adequate off training measures are also essential, especially when renovating pipeline, in order to ensure that any deterioration in the remaining portions of the network. In addition to preventive measures to minimize deterioration, emergency measures must also be taken when necessary, for which special equipment is needed, possibly back-fup by arrangements for a supply affected area by tanker or, in extreme circumstances, by rail. **France**

**95-0286\***

**A geographical information system for the Rome water network**

M. DEL RE (Azienda Comunale Energetica Ambientale Roma) and E. ORIANDI

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille*  
*France* Volume 2, 1994, 285-292 (in English)

The approach adopted by the Rome water supply undertaking (ACEA) in developing a GIS system covering the area supplied (300 km<sup>2</sup>, population 3,200,000) with 540 million m<sup>3</sup> water per year is described. The system was designed to improve operational efficiency and to weld together a number of existing databases with

## UNDERGROUND SERVICES

the aim of an accurate and rapid method of combining all relevant information relating to a specific part of the network. The technical features of the system are outlined and the mode of operation for the active management of maintenance activities are discussed. The system also has a useful public relations function, allowing information regarding the effects of plant breakdowns and deliberate interventions to be rapidly assessed and communicated to those customers directly affected. **Italy**

95-0287\*

### **EAUCEANIX: a program for modelling a pressure mains network.**

R. CHOUX (CISE - Rued Malmanson)

*HYDROTOP 94 Colloque Mieux gérer l'Eau, Marseille, Vol. 2, 1994, 504-506 (in French)*

The capabilities of the EAUCEANIX software are outlined: the system providing an effective method for simulating the hydraulic behaviour of a mains distribution system. It can provide a semi-dynamic representation of the state of the network in space and time and can predict the rate of movement and the route taken by a particular substance between one point and another in the network, while it also enables the residence times to be calculated for water moving from the point of origin to any given point in the network. The mode of application of the model and its advantages as a management tool for the operator of a complex distribution system are discussed. **France**

95-0288

### **Optimal design of water distribution networks.**

G. FLEGER (Technion-Israel Institute of Technology, Haifa) and SHAMIR, and A. BEN-EL

*Water Resources Research, 1994, 30, No 9, 2637-2646*

The problem of designing the lowest cost water distribution network which could supply given demands within specified constraints is considered. The optimal design was formulated as a two-stage decomposition model. The master or outer problem was non-smooth and non-convex, while the inner problem was linear. A semi-infinite linear dual problem and an equivalent finite linear dual problem were formulated. The overall design problem was solved globally using a branch and bound algorithm using non-smooth optimization and duality theory. The solution process was complete when the difference between a bound and the true global optimum was within a prescribed tolerance. **Israel**

95-0289

### **Environmental and technical considerations in the design of water supply and distribution systems.**

W. HIRSNER (EWAG Energie und Wasserversorgung AG, Nurnberg, Germany)

*Water Supply, 1994, 12, No 1-2, IR 5-1, IR 5-6*

An international overview on environmental and technical considerations in the design of water supply and distribution systems is presented based on subsequent national reports. There was concern about the effect of water supply facilities and the laying of pipes on the environment generally. Many countries required environmental impact assessment (EIA) for significant projects. The EC directive on EIA required a description of their impact on human beings, flora, fauna, soil, air, water, the landscape, material assets and cultural heritage. The architecture and landscaping of water utility installations were of increasing importance. Controls on pipe installations and repairs had addressed trench construction, tree damage, noise and reinstatement in addition to pollution problems from the disin-

fection of pipelines. Technical aspects receiving attention were energy recovery, minimization of water losses and the selection of pipe materials which did not contaminate water with corrosion products. **International**

95-0290

### **Pipeline construction under adverse conditions.**

A. KOTTMANN (Technische Werke der Stadt Stuttgart AG), and O. HALTER

*IR International, 1994, 33, No 9, 480-485 (in German, English summary)*

The problems presented by the installation of buried water pipes in difficult ground conditions such as those where settlement is liable to occur, or where large boulders are encountered, are discussed. The bending stresses which may be imposed place a considerable strain on the pipe material itself and also on the integrity of the seal between adjacent pipe sections. The manner in which these difficulties have been overcome and the development of effective jointing systems capable of sustaining angular displacements without leakage is reviewed. Adequate external corrosion protection must be applied, usually in the form of a cement mortar or GRP external jacket. Causes of failure of plastic pipe are also considered, including stress cracking and low fatigue resistance for earlier forms of polyethylene pipe, together with the superior long-term properties of the recent modified forms such as crosslinked PE. The differences are illustrated with reference to graphs indicating the expected service life of different materials as a function of the applied load. A further problem involving the failure of cement mortar linings in ductile iron pipe, especially along a line parallel to the crown, is also discussed and explained. By eliminating high spots, pockets of residual air in the pipeline should be prevented from occurring in order to suppress the release of air entrained within the coating in response to pressure surges. (English translation 130 pounds sterling, valid for 1995)

**Germany**

95-0291\*

### **Pipelining using trenchless methods.**

O. PASCAL (Compagnie Generale des Eaux, Paris), and D. ROCHET

*HYDROTOP 94 Colloque Mieux gérer l'Eau, Marseille, Vol. 2, 1994, 257-265 (in French)*

The progress achieved by the joint water undertaking for the greater Parisian area in the use of trenchless methods for the installation and relining of water mains is reviewed. The Compagnie Generale des Eaux has been using polyethylene pipe for around 30 years as a replacement for lead service pipes and also for about 10 years for the installation of new water mains. Coupled with the flexibility and merit of polyethylene, trenchless installation methods have presented numerous benefits in reducing the disturbance associated with conventional excavation and trenching systems. Several of the techniques which have been successfully adopted are briefly described, namely pneumatic mole driving, hydrojet propulsion and pipe jacking systems for the installation of new pipes and various techniques of relining or replacement of existing pipes, including the use of the patented SADI Extractor equipment for installing plastic pipe in place of lead for service connections. Swage lining and cured in place systems are also briefly discussed. With the increasing familiarity and reliability of such methods it is hoped to achieve a target of 50 per cent of pipe installation work using trenchless methods in the next 5 years. **France**

95-0292

**Diffusion through HDPE pipes.**

W. MEVIUS

*IR International* 1994 33, No 9 492-496 (in German-English summary)

The various types of polyethylene (PE) are distinguished and the properties of PE pipe are discussed at length, with particular reference to the high-density form (HDPE) now widely used for drinking water supply, especially for service connections. A review of published data concerning the permeability of the material to certain gases and solvent vapours is presented, together with reports of the contamination of drinking water occasioned by the diffusion of volatile compounds through the pipe wall. Such occurrences in the Netherlands and elsewhere during the 1980s are reviewed, followed by a summary of permeation studies recently carried out by the Dutch organization KIWA. These demonstrated that the permeability of both LD and HD polyethylene pipes was similar at equal pressures and that lipophilic substances were able to diffuse more rapidly through the pipe wall than polar substances. The rates of permeation of aromatic compounds and chlorinated hydrocarbons were much greater than those for ketones, alcohols and phenols of similar molecular size. In the unsaturated zone the test compounds penetrated more rapidly than in the saturated zone. Special care must be taken to ensure that the soil surroundings are free of such contaminants where HDPE pipe is used in the drinking water network. The inclusion of a barrier layer, eg metal foil, is also advocated as a possible method of excluding possible contamination, by analogy with electric cables. **Germany**

95-0293

**Tales from the pump room.**

K. HAYWARD

*Water & Environment Management* 1994 No 10 21 and 23

A more sophisticated approach to choosing and using pumps could improve pump efficiency and yield considerable savings for water companies. A risk and reliability assessment should be carried out when a pumping station was being designed or refurbished. The assessment would examine the effect of failure of components of the system to identify critical items. A review of the water companies' existing performance data would also provide a good starting point. **UK**

95-0294

**Determination of the degree of utilization of a water distribution system from an analysis of measured data.**

F. BLANC (Société du Canal de Provence et d'Aménagement de la Région Provençale, Aix-en-Provence) and C. MAGNIN *HYDROTOP 94 Colloque Municipal Eau Marseille* Vol 1 (Feb 1994), 267-275 (in French-English summary)

Both customer demand and system performance undergo appreciable changes with the passage of time, the demand increasing while the performance declines as a result of ageing in various ways. In order to estimate the margin remaining between the expected requirements and the system capability a survey procedure was initiated by the Société du Canal de Provence (SC) which involved the installation of a chain of flow meters, pressure and level recorders for measuring the state of the system, and the definition of 2 indices representative of the degree of utilization of production equipment and the distribution system. The first index termed the utilization factor for production systems (F.U.L.) was determined by comparing the maximal level of output with the demands of consumers taking into account temporal and seasonal fluctuations. The second index

termed the network degree of utilization (D.U.R.) was obtained from a study of the margins of pressure existing at any point and calculating the additional rate of flow needed to reduce the margin to zero. The manner in which these indices can be applied to an optimization of the network performance is briefly considered. **France**

95-0295

**Are your water rates accurate?**

S. L. LANGRISH

*Public Works* 1994 125, No 10 77-78

In 1987, following a ruling by the Texas Water Commission, a service study was performed by the Austin city and water rates were calculated based on the results. To achieve this, the water and wastewater utility began an hourly flow monitoring programme for wholesale, commercial and particularly residential customers. Selection of sites and monitoring equipment is discussed. The installation and performance of the flow meters is described. The obtained results had been used to determine the city's water usage, the residential sector having the highest peaking factors. Costs were thus distributed among all the customer classes rather than charging just a few. **U.S.A.**

95-0296

**Flow meters using transit time technology solve Mexican authority's accuracy and reliability problems.**

*Water Engineering & Management* 1994 141, No 8 12-13

The city of Monterrey received ground water and surface water supplies from various locations outside the city. Raw water was treated at different water works before distribution. To ensure accurate and dependable flow measurement of the raw water intake, several alternatives were investigated before deciding on transit time technology, which would allow for future centralized operation. More than 45 ultrasonic flow meters were installed throughout the collection and distribution system. **Mexico**

95-0297

**Internal corrosion of pipes in public water distribution networks.**

E. WAGNER (DVGW Research Institute, Karlsruhe, Germany)

*Water Supply* 1994 12, No 1/2 1R 7-1R 7-8

An international overview, obtained from national reports is presented on internal corrosion of pipes in public water distribution networks. Although corrosion could weaken pipelines and result in failure, the major problem arose from corrosion products, causing a decrease in capacity and degrading water quality. The behaviour of cast iron, ductile iron, steel, cement based materials, lead, galvanized steel, copper and its alloys are discussed. Long contact times, low dissolved oxygen and low pH favoured the diffusion of ferrous ions which subsequently oxidized and produced discoloured water. Scrapping and relining with cement mortar was the best remedy. Cement linings could be attacked by low alkalinity waters to give unacceptably high pH values. In general, these difficulties only modestly restricted the value of cement linings. Lead solubility, which was favoured by low pH and low alkalinity, was usually controlled by pH correction. Plumbosolvent hard waters were improved by orthophosphate addition. Release of lead from solders, brasses and bronzes was also of concern as standards tightened. Galvanized steel could pit or uniformly dissolve, causing pipe blockages or pollution by zinc, cadmium and lead. Pitting of copper could take place in certain waters and was a complicated process. All these phenomena posed problems for water utilities, mostly in the field of water quality. **International**

## UNDERGROUND SERVICES

95-0298\*

### **Permanent pipe network monitoring (PPNM): procedure for the early recognition of leaks in water pipe networks.**

M. BÜCKLER (Stadtwerke Saarbrücken AG) and H. SCHIMMELZIK

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille France - Volume 2 - 1994, 221-228 (in English)*

A method of continuous monitoring of the Saarbrücken water distribution system is described which enables leaks or pipe bursts to be recognised soon after their occurrence. The method depends on the permanent installation of an electromagnetic flow meter at the entrance to each of the network zones into which the system is divided with provision for recording flow rates during the period of minimal consumption from 2.00 to 3.00 am. The data are held in a data logger for intervals of 4 weeks, after which they are transferred using a data storage device and subsequently downloaded into a personal computer with facilities for graphical output. A plot of the daily minimal flow versus time indicates the occurrence of new sources of leakage which when they reach a certain magnitude must be subjected to location and repair using established methods. The manner in which this method has been applied to the distribution system for Saarbrücken is described, enabling the annual wastage to be reduced from 2.9 m<sup>3</sup> in 1985 to only 1.2 m<sup>3</sup> in 1992. Estimates of the capital costs incurred in the purchase and installation of the necessary equipment are given. Each metering point may involve an outlay of approximately 50 000 DM. **Germany**

95-0299\*

### **Improving water management in leakage control.**

M. FARLEY (WRc plc, Swindon) and I. MARTIN

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille France - Volume 2 - 1994, 319-327 (in English)*

The circumstances leading up to the establishment of the National Leakage Initiative (NLI) in the U.K. are reviewed, including preliminary surveys and reports concerning the extent and control of leakage from water mains in the U.K. The pace of technical development and the need for standardization across all water undertakings, coupled with a heightened level of public awareness of the economic consequences of leakage, all contributed to the demand for an updated systematic study of leakage control procedures. The manner in which this study is being pursued is outlined, and several specific approaches identified, namely flow measurement and monitoring methods, data capture and communication, data analysis and interpretation, and leak location. A management strategy for effective leakage control is proposed, based upon a composite model of leakage components and including economic considerations in the overall scheme. **U.K.**

95-0300

### **Heart of the matter.**

I. EDWARDS

*Water Bulletin - 1994, No 621, 10-11*

A water pressure management system devised by John Lindley of South Staffordshire Water was awarded the Engineering Council's Environment Award for Engineers. The Energy Efficiency Office assessed water and energy savings in a multi-feed zone with 20-40 year old paperwork and estimated a payback period of 8 months. Reducing pressure at night reduced water leakage. Pressure reducing valves (PRV) lowered water pressure in distribution systems when demand was low, allowing lower operating heads. The system used a programmable logic controller, standard pressure transducers, small solenoid operated water valves and a conventional PRV. It

could be retrofitted *in situ* to most PRV and solved the problem of sand or grit in the small orifices of a conventional PRV. Seven systems were installed in South Staffordshire's area. **U.K.**

95-0301

### **Water supply networks - future strategy: research into the occurrence of external corrosion and its prevention in Zurich.**

C. SKARDA (Wasserversorgung Zurich)

*Gas Wasser Abwasser - 1994, 74, No 8, 649-657 (in German, English summary)*

The basic requirements for the protection of the water distribution network and its correct performance are discussed in view of the problems and responsibilities of the Zurich water supply undertaking. Three dominant principles involve the maintenance of an acceptable supply, the extension of the network to serve new built up areas and the maintenance of the existing assets. The quality of the drinking water, the hydraulic performance of the network and the condition of the pipework must all be subjected to routine monitoring with a view to periodic overhaul and replacement of those parts with evidence of deterioration. The methods employed in planning pipe replacements, in estimating the service life of different pipe materials, and in reducing the costs of replacement by relining and similar techniques are reviewed. The use of certain performance indices as a measure of the cost per km for various network replacement or rehabilitation measures, including preventive maintenance, is described, together with estimates of the leakage rate as a function of the amount entering the network, which presently stands at only 6 per cent. The nature and causes of external corrosion of steel pipe, which has proved to be exceptionally severe, are also considered, including the measures designed to eliminate the problems caused by stray electric currents, earth connections and aggressive soil conditions. (English translation 220 pounds sterling, valid for 1995)

**Switzerland**

95-0302\*

### **Service to the consumer as a criterion of the need of replacement.**

B. CHOIX (CISE, Rue du Malmoussin) and D. HOUILLON

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille - Volume 2 - 1994, 123-134 (in French, English summary)*

The possibility of employing criteria linked to the quality of service to the consumer as an indication of the need for replacement or rehabilitation of a given part of the network was investigated. The 3 aspects of service considered are: the quality of water supplied, the constancy of the supply (freedom from interruptions) and the pressure of water at the customer's outlet. The manner in which these factors changed as the network aged is discussed, together with a consideration of how the rate of change was determined by serial sampling and headloss determinations over a period of time. Given a knowledge of the rate of deterioration of any of the relevant parameters, a point in time when the supply would become unacceptable can be determined. This provided an indication of the residual 'service life' of any part of the network, as a basis for a planned intervention in order to arrest the decline in level of service before it breaches the limits of customer acceptability. Some data concerning the practical application of the method are reported. **France**

95-0303\*

**Predicting rates of failure and renewal in water distribution networks.**

B. BREMOND (CEMAGREF Bordeaux, Gazieta), and P. EISENBEIS

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille* Volume 2, 1994, 175-183 (in French, English summary)

For the effective planning of maintenance and repair activities for a water supply network, an estimate of the probable failure rate in different parts of the network is essential. To provide some indication of the expected behaviour a survey of 3 networks for which adequate records were available was performed. The risk of failure within a certain period was a function of the size of the pipe, the number of antecedent failures in a given time, and also the nature of the pipe material, the soil, traffic density and position in the roadway. Taking these variables into account, and using statistical models of the Cox and Weibull types, expressions were derived for predicting the failure rates for particular networks, which were calibrated with reference to existing data. Assuming that similar behaviour could be expected in other networks of comparable type, the model could be used to plan remedial measures for areas or networks for which failure statistics were unavailable. **France**

95-0304\*

**Database to prioritize mains rehabilitation**

M. J. KANE (Severn Trent Water Ltd, Birmingham)

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille* France, Volume 2, 1994, 201-212 (in English)

The various sources and methods of grouping and storing data relating to the water distribution system managed by Severn Trent Water are outlined. The various categories in the databank comprise water quality information, levels of service, maintenance cost, leakage, and structural condition of the pipework. This information is recorded within each of a series of District Metering Areas, which generally consist of a group of approximately 5000 consumers supplied via a metered delivery point from a single identifiable water source. Within these areas the data are assessed with the aid of certain weighting factors for individual failures under the stipulated head. The final values forming a set of priority indices on which the timing and implementation of remedial works can be based. The manner in which the data are assembled and classified, together with the factors taken into consideration in assigning the different weightings, are discussed, and examples of the format used for presentation of the data are given. **U.K.**

95-0305\*

**Drinking water networks - costs of pipeline renewal**

J. J. PALOS (Syndicat Intercommunal de l'Estéron et du Val d'Encrenaz, Carros)

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille* Volume 2, 1994, 213-219 (in French, English summary)

In recent years drinking water networks have extended from the towns into the suburbs resulting in major increases in the size of the networks operated in many cases by municipal authorities. As the work of extending the networks was virtually complete, concern had been directed to the probable costs of renewal during the years ahead. Very few of the local councillors and those controlling municipal networks were aware of the costs likely to be incurred in the future. A simple method of calculating these costs is presented based on the age structure of the existing network, broken down into pipes above and below 100 mm diameter. Life expectancies of 40-60 years are assumed for pipes of under 100 mm diameter and 50-70 years for

pipes larger than 100 mm diameter. Phased renewal costs are calculated for the periods from 1992-2001, 2001-2010, 2010-2016 and 2016-2020; the validity of the calculations will be checked over the coming years for the network concerned which had a total length of 400 km. **France**

95-0306

**Optimal rehabilitation model for water-distribution systems**

J. H. KIM (Korea University, Seoul), and L. W. MAYS

*Journal of Water Resources Planning and Management*, 1994, 120, No 5, 674-692

A new methodology is presented for deciding on the rehabilitation and/or replacement of pipes in an existing water distribution system in order to satisfy water demand and pressure requirements while minimizing total cost. The proposed model formulation was a mixed integer nonlinear programming problem and the optimal combination for the integer variables representing the optimal rehabilitation scheme was obtained by an implicit enumeration algorithm using a branch and bound procedure. The nonlinear subproblem size was reduced by using the nonlinear solver GORGE (in which pipe diameter and pump horsepower were the decision variables) to interface the hydraulic simulator KYPH and by using a penalty function method to incorporate the bound constraints into the objective function. Three example applications demonstrated the ability of the proposed model to provide optimal solutions with costs lower than the minimal total cost of a system configuration obtained from the generation of 1000 random system configurations. **South Korea**

95-0307

**Research needs for water distribution system rehabilitation**

A. HABIBIAN (Washington Suburban Sanitary Commission)

*Water Engineering & Management*, 1994, 141, No 8, 25-27

The cost of rehabilitating U.S. water and wastewater facilities was estimated as more than 160 billion U.S. dollars. Innovative research was needed to develop cost effective techniques. Critical research areas were identified as: water main condition assessment, rehabilitation techniques, rehabilitation management, causes of water main breaks, main break prevention, design procedure modification, pipe material performance, and earthquake hazard effect. **U.S.A.**

95-0308

**'Retrocat' and 'Retrovac' - in situ cathodic protection of existing ductile iron pipes**

B. M. GREEN (Severn Trent Water Ltd, Birmingham), and P. J. de ROSA

*Water Supply*, 1994, 12, No 3, 255-301, 353-305

Cathodic protection of existing ductile iron pipes is discussed. The issues to be resolved were: whether an anode attached near the end of a 5.5 m long pipe would protect the whole length; whether it would be sufficient to locate the anode over the pipe; and to identify the costs compared with conventional relaying. Initial trials with magnesium anodes showed that all pipe potentials were suppressed below corrosion level. A full scale trial indicated reduced potentials at all locations with 75 per cent below the critical value. Installation procedure involved locating the main, cutting a 400 mm diameter hole in the pavement, micro excavation by water jet and vacuum extraction, anode connection by brazing, then backfilling and the installation of monitoring points at selected locations. This approach cost around 50 per cent of replacement costs. **U.K.**

## UNDERGROUND SERVICES

95-0309

### Private sewer connections - a maintenance problem for the future

F. HILFERS (H. I. Ingenieurgesellschaft für Leitungsbau und Leitungsinstandhaltung, Detmold)  
*IR International*, 1994, 33, No 9, 472-479 (in German-English summary)

The magnitude of the problem presented by service connections to private properties, which form around 50 per cent of the linear extent of the German sewerage system, is reviewed. These pipes, which are mostly installed on private property, suffer from the same defects as the municipal sewerage networks to which they are connected, but have so far been largely ignored because of both legal and technical problems concerning access. The legal position is considered initially, followed by a review of technical approaches, mostly based on the use of robot cameras for inspection purposes and remotely controlled relining techniques for repair or rehabilitation of a defective pipe. Special equipment has been developed for making good the joint between the main pipe and the service pipe, while various conventional relining methods have been adapted for use in the smaller diameter branch pipes. A table listing the nature of the defects observed and the relining methods most appropriate to their elimination is provided. (English translation, 330 pounds sterling valid for 1995). **Germany**

95-0310

### The behaviour of gross solids in sewer systems

C. JEFFRIES (Aberley University, Dundee) and R. M. ASHLEY

*European Water Pollution Control*, 1994, 4, No 5, 11-17

The behaviour of gross solids (greater than 6 mm), including faecal stools and sanitary refuse, in sewer systems is poorly understood. Studies on the behaviour of gross solid behaviour are reviewed. Field studies at 2 combined sewer sites in Scotland, conducted using a Gross Solids Sampler (GSS), developed by WRc, are described. The research resulted in the development of a method for estimating gross solids production and showed that the flow of gross solids particles was similar to that of type C sewer solids. **U.K.**

95-0311\*

### Controlling septicity in the Costa do Estoril sewerage system

J. S. MATOS (DRENA, Lisbon), P. C. de COSTA, C. MELO, A. V. FRAZAO, M. B. GUEDES and A. GAMA

*HYDROTOP 94, Colloque: Management de l'Eau, Marseille, France, Volume 2*, 1994, 153-159 (in English)

A new 2.3 km trunk sewer serving more than 1 million inhabitants of the coastal zone of the Tagus estuary near Lisbon, was in the final stages of construction. Since the occurrence of septic conditions in this sewer was predictable on theoretical grounds, special precautions were being introduced as a means of sulphide control. Field studies were carried out on a branch sewer to assess the rate of reaction between hydrogen peroxide and sulphide ions in the sewage as a basis for the design of permanent injection facilities in the new sewer. The evolution of sulphide concentration in the sewage in response to dosages of hydrogen peroxide representing various molar ratios of sulphide to peroxide was examined. From the results a system comprising 3 dosing points along the trunk sewer was proposed, coupled with a 2:1 ratio of hydrogen peroxide to sulphide ions, and the chemical dosing facilities were designed accordingly. **Portugal**

95-0312

### Need for new standards to prevent deposition in wastewater sewers.

C. NALFURI (Newcastle University) and W. DABROWSKI  
*Journal of Environmental Engineering*, 1994, 120, No 5, 1032-1043

The influence of sewer flow depth on the tendency to deposit sediment or to wash out previously-formed deposits was investigated. The criteria of minimal self-cleansing velocity and minimal shear stress both showed that the relative flow depth was an important parameter in relation to these tendencies and should be taken into account in formulating new codes of practice. Approaches using both these criteria indicated that deposit free conditions would be obtained with flow depths in the half full to full flow range. Deposits tended to form at lower flow depths. Shear stresses in partially clogged sewers are considered in relation to deposit thickness. **U.K.**

95-0313

### Asset valuation and determination of charges on the basis of the normal service life of pipes and sewers.

J. SAWATZKES & K. Sawatzki & Kerkenmeier GmbH (Schwerte)

*Korrespondenz Abwasser*, 1994, 41, No 9, 1520-1524 (in German-English summary)

Since the construction and maintenance of the sewer network constitute 2 of the most capital intensive operations for which a sewage undertaking is responsible, the calculation of their economic impact on the provision of sewerage services has an important bearing on the scale of charges levied by the undertaking. The calculation of this standing charge must, however, be based on a realistic assessment of the expected life of the network, from which a meaningful value for its rate of depreciation can be derived. As these factors are dependent on a wide variety of technical considerations, such as the nature of the pipe, its diameter, the ground conditions and general state of repair, a systematic survey of the network is necessary, coupled with detailed records of the age and previous history of different sections. From such data it is possible to derive an estimate of the expected life of any given part of the network and to calculate the annual depreciation provision as the quotient of the replacement cost and the operational period remaining. Examples of this method of approach are given, based on the application of published guidelines and Codes of Practice for assessing the state of the sewer network. (English translation 140 pounds sterling valid for 1995). **Germany**

95-0314

### Environmental protection - a pipe dream or reality?

J. H. RYLANDS (Portsmouth University)

*Municipal Engineer*, 1994, 103, No 3, 121-128

The water industry had recently embarked on a major programme of capital expenditure which included improving wastewater treatment facilities and reducing the possibility of breaches of discharge consents. The problems of infiltration and exfiltration from the sewerage pipeline network are considered. The economic, legal and environmental aspects of these infiltration and exfiltration flows are examined by discussing their effects on each stage of wastewater collection and treatment. Various options for controlling pipeline leakage are described including relaying, on line replacement, secondary lining, isolated repairs and system sealing. **U.K.**

95-0315

**A sea change on coastal pollution.**

H. MARRIOTT (North West Water), and T. TAG  
*Tunnels & Tunnelling* 1994, 26, No 9, 27-29

North West Water's Coastal Waters Interceptor Project was described at a British Tunnelling Society meeting at the Institution of Civil Engineers at Southport. The project involved rebuilding of the sewage works and construction of a new trunk sewer which intercepted 4 sea outfalls. Following treatment at a pumping station, the flows from the interceptor tunnel would be discharged via a new sea outfall. Most of the tunnel would be in alluvial sand with a high water table. A Loyal M131 tunnel boring machine was used. Management of the contract and the tunnel drive are described. U.K.

95-0316

**Sandwich spread.**

M. HADDON

*Water Bulletin* 1994, No 621, 7-9

Southern Water Service's Sandwich bay project was part of the 450 million pounds sterling Operation Seaclean. The bathing waters of Sandwich bay had consistently failed to meet EC standards. Stormwater tunnels were being dug under Ramsgate to provide stormwater capacity before feeding the new Weatherlees Hill wastewater treatment works. Pumping stations were under construction at Ramsgate, Deal and Sandwich. New stormwater outfalls were being pipelocked at Ramsgate and Deal. The Weatherlees Hill works used activated sludge processes with primary settlement, aeration lines and final treatment tanks. The effluent treated to a standard of 30, 20 and 10 mg per litre for BOD, suspended solids and ammonia, respectively, would be discharged to the Stour river where it was hoped that the river flow would help to block saltwater intrusions and compensate for abstraction by a nearby power station. U.K.

95-0317

**Sewer design on dynamic principles**

E. P. G. GANZEVILS/Gronting Advies and Techniek by Dr. B. van den Hul and H. van Eijndhoven

*European Water Pollution Control* 1994, 4, No 5, 18-23

Due to the fact that most of the drainage systems in the Netherlands combined, 80-90 per cent of the annual rainfall runoff is treated at sewage treatment plants. The design of typical sewer systems in the Netherlands is described. New regulations have been introduced to reduce pollution of receiving waters. Current design methods are unsuitable for optimizing measures to control overflow loads. A computer-aided design method, called *dynamic design* was developed by Gronting Advies and Techniek by. The method aims at the efficient use of ancillary sewer facilities to minimize the effects on receiving waters. The application of dynamic design to sewer design in Utrecht, Dordrecht and Bodegraven is described. Netherlands.

95-0318

**Smart sewer systems: Improved performance by real time control**

W. SCHILLING (Norwegian Institute of Technology, Trondheim)  
*European Water Pollution Control* 1994, 4, No 5, 24-31

For most of the time part of the capital invested in urban drainage systems is unproductive, useless and wasted. To improve the situation the supervising agency must define performance criteria for the entire urban drainage system and not only for the sewage treatment plant. Real time control technology has to be implemented to enable the operating agency to control and improve the performance of its urban drainage system. Real time control of sewer systems is de-

scribed. Criteria are presented for making a preliminary assessment of the potential benefits of real time control. Conceptual planning and detailed planning of real time control systems are discussed. Real time control systems in operation in Germany, Denmark, France, Germany and the Netherlands are described. Norway.

95-0319

**Transport of sediment in pipes - application to design of self-cleansing sewers.**

R. W. P. MAY, HR Wallingford Ltd, Wallingford

*European Water Pollution Control* 1994, 4, No 5, 57-64

The types and sizes of sewer sediment vary with sewer type, geographical location, catchment type, catchment slope, operation procedures and local customs. Models of sediment transport are outlined. Design criteria for self-cleansing sewers and research relating to sediment transport in pipes are reviewed. The requirements for an efficient self-cleansing system are expressed in terms of 4 criteria: erosion of cohesive deposits; transport of organic and fine-grained sediments in suspension; and transport of coarser inorganic materials as bed load. The results indicate that economic designs of self-cleansing sewers may be achieved by allowing a limited amount of sediment deposition. U.K.

95-0320\*

**Optimizing the performance of urban drainage systems by means of better management and real-time operation.**

E. NELEN/DHV Environment and Infra-structure, Amersfoort

*HYDROTOP'94 Colloque: Mieux gérer l'Eau, Marseille*

France, Volume 2, 1994, 229-236 (in English)

An effective solution for urban drainage control problems is proposed, based on the application of a thorough systems analysis at the design stage, using the Integrated Sewer Management System (ISMAS) procedure, coupled with real-time operational control using the Local versus Optimal Control of Urban Drainage Systems (LOCUS) model, which ensures that all available capacity is utilized to the best advantage. Since the distribution of rainfall is non-uniform both in space and time over the whole of the sewer catchment, even a properly designed network will not be utilized to maximal efficiency at all points simultaneously. The LOCUS program could be used to divert flows to those parts of the system which had spare capacity at any given point in time. Two systems using this method in The Netherlands were situated in Weerschoot and Olburgen. Savings in construction costs due to an avoidance of over-design for maximal capacity at all points could more than compensate for the additional costs of control equipment using the LOCUS principle. Netherlands.

95-0321\*

**Risk assessment in the management of drainage networks**

J. M. BIERGUE/ESTU (Ministère de l'Équipement), Paris, and J.

E. GUERIN

*HYDROTOP'94 Colloque: Mieux gérer l'Eau, Marseille, Vol*

ume 2, 1994, 237-245 (in French, English summary)

As a basis for the development of a preventive maintenance programme for an urban sewerage network, a first stage is outlined which involves the identification of those parts of the network considered to be at risk. The system involves an assessment based on the use of site inspections and estimates of the susceptibility to failure due to ground conditions, hydraulic loading, structural faults and mechanical impact damage. Certain checklists are employed to assist in the recognition of potential failure sites, and the application of these is considered with reference to 2 final sewer catchments.



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forming part of the Bordeaux Urban Drainage Network. The methodology described represents a simplification of the approach previously applied on certain very large sewerage systems in the Paris region. **France**

### 95-0322

#### **Trenchless installation of sewerage networks using remote-controlled pipe-jacking.**

H. P. UFFMANN (Ingenieurburo Dr. Uffmann, Aachen)  
*IR International*, 1994, 33, No 9, 458-463 (in German-English summary).

The benefits associated with trenchless methods for sewer construction and the progress achieved in the application of the method in Germany during the last 15 years are reviewed. Between 200 and 250 remote controlled pipe jacking machines are now in service capable of installing 100 km per year of sewer pipework of dimensions up to 2000 mm nominal diameter. Examples of the various types of equipment are discussed, comprising both hydraulic propulsion and screw conveyor systems for advancing the drilling head. The method is applicable to a wide variety of pipe materials, which may be inserted in sections as the drive proceeds, or subsequently on withdrawal of the steel casing surrounding a screw type drilling head. The functions performed by the remote control station of the micro-tunnelling system are also considered, involving directional control, speed of advance, lubrication of the cutting head and evacuation of the space. A further essential requirement is a prefabricated shaft from which the pipe is fed into the opening as tunnelling proceeds. The method may be used to install lateral connections in existing main sewer pipes and in the case of large interceptor sewers, the tunnelling work may commence from inside the sewer and proceed towards the property or other equipment to be connected. (English translation 200 pounds sterling valid for 1995). **Germany**

### 95-0323

#### **Texas tightens collection system requirements.**

E. BADDACKER (Freese and Nichols, Fort Worth, Tex.)  
*Water Environment & Technology*, 1994, 6, No 9, 35-36.

What are believed to be the most stringent conditions in the entire U.S.A. for the replacement or enlargement of sewers (collection systems) imposed by the Texas Natural Resources Conservation Commission are detailed. The regulations are intended to prolong the life of sewers and reduce rehabilitation costs through getting it right at the outset. Although the requirements vary according to the material used for the sewer, a minimal life of 50 years is stipulated, as is a minimal flow of 2 ft per second, in order to reduce pipe degrading anaerobic conditions. Greater attention is also called for in respect of the water tightness of manhole covers, to reduce the risk of soil washout and the attendant lack of sewer support. Design engineers are required to declare the methods they used to calculate the modulus of soil reaction when using flexible pipes, and what factors they have allowed for stresses of various types. For rigid pipe installations, such factors as trench width, water table height, depth of cover, and minimal strength (according to the Standards of the American Society for Testing and Materials) of the class of material selected must be shown. There are also revised regulations for air pressure testing of the sewer line once installed, and for leakage of and at manholes, while a deflection limit of 5 per cent of the diameter will apply to all flexible pipes. **U.S.A.**

### 95-0324\*

#### **Controlling biogenic corrosion of concrete sewers.**

H. SIMA (Ecology and Environment, Inc., Fresno, Calif.), and R. G. ARNOLD

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille, France*, Volume 2, 1994, 167-174 (in English).

Reports of rapid and severe biogenic corrosion of sewers due to the action of *Thiobacillus thiooxidans* in oxidizing sulphide ions to sulphuric acid have prompted a search for a specific inhibitor capable of inactivating this organism. Chemical inhibition experiments are described which were directed at the processes by which bacterial carbon dioxide fixation occurs in this species. The effectiveness of a number of inhibitors was monitored by simultaneous measurement of a range of parameters including cell growth rate, acid production, aerobic respiration, carbon dioxide assimilation and ATP levels. The compound 2-(carboxyl-D-arabino)-1,5-bisphosphate (CABP) effectively blocked carbon dioxide assimilation and growth of the species concerned; hydroxylamine also exhibited a similar inhibitory action. The use of specific inhibitors such as these could give rise to selective inhibition of the *Thiobacilli* spp. without endangering the general sewer microflora or the downstream biological sewage treatment operations. There are 35 references. **U.S.A.**

### 95-0325\*

#### **The extent of infiltration into sewerage systems in response to rainfall.**

C. IOANNIS (Laboratoire Central des Ponts et Chaussées, Bouguenais), N. BELHADJ, and G. RAIMBAULT

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille*, Volume 2, 1994, 301-309 (in French-English summary).

A study of the extent of infiltration into foul sewers occurring during rainfall events of measured duration and intensity was performed in 2 sample catchments of differing characteristics. One of these was a sewer network serving a rural location with few branches and laid mainly in unpaved surroundings, while the other was a principally urban catchment, highly branched, with the sewers laid chiefly beneath the carriageway. The variation in the rates of flow in the sewer was correlated with the occurrence of rainfall events and with changes in the water table resulting from the infiltration of rainfall into the unsaturated zone. The results were analysed with the aid of mathematical models, from which it was possible to distinguish different patterns of response to rainfall events, associated with different mechanisms of infiltration. In certain cases the bedding material acted as a storage compartment and external flow pathway, accompanied by delayed infiltration into the sewer. **France**

### 95-0326\*

#### **Pollution load of subsoil, groundwater and surface water by leaky sewers.**

J. DECKER (RWTH Aachen)

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille, France*, Volume 2, 1994, 293-299 (in English).

Interim results obtained from a series of field investigations carried out on 12 different lengths of sewer in different cities and districts to determine the rate of exfiltration at various hydrostatic heads are reported. The experiments involved 48 separate damage or leakage points, the tests being performed with the aid of a portable device comprising a pair of packers for isolating a short length of pipe and a system of pressure control for varying the hydrostatic head applied to the isolated segment. The rate at which water flowed out of the damaged segment in response to various applied pressures (from a head equal to the pipe diameter to that equal to the distance from the

invert to the manhole cover) was determined at each site. The results are presented in the form of a distribution chart and graph: the rates of exfiltration as a rule were in the range 100-200 litres per h for a pipe full from invert to crown, and the rate increased to 1000-1500 litres per h as the hydrostatic head was raised to the maximum which was usually about 3.5-4.0 m water gauge. **Germany**

95-0327

**Trenchless rehabilitation of defective sewers.**

U. WINKLER (U. Winkler Ingenieurbüro für Umweltberatung Lemgo)

*IR International*, 1994, 33, No 9, 464-471 (in German, English summary)

The various types of defect affecting the performance of the German sewerage network, with a breakdown of their relative importance, are discussed as a background to a review of the latest techniques for pipe rehabilitation *in situ*. For repair of localized damage, injection methods may be employed using packers to isolate the damaged section, while for complete relining resin-impregnated fabric linings may be used and these have recently been adapted for use in service pipes, where they can be internally pressurized by compressed air before curing. Other relining methods are also described, including the insertion of short lengths of plastic or GRP pipework, the burst lining and close fit lining methods, and less conventional techniques such as spiral wound interlocking strip (Riblok) and the T-lining method which employs ribbed flexible sheets arranged back to back to give a type of sandwich construction. This may incorporate a barrier layer of foil or similar material to prevent diffusion of volatile solvents or other vapours across the wall of the pipe. Some of the technical and economic factors governing the use of these methods are outlined, together with the quality assurance aspects designed to ensure adequate service life and integrity of the lining. (English translation, 270 pounds sterling, valid for 1995). **Germany**

95-0328

**Special-purpose equipment systems for the rehabilitation of pipes of non-man entry diameter.**

F. R. DIER (Preussag Rohrseamerung GmbH, Hamburg)

*IR International*, 1994, 33, No 9, 486-491 (in German, English summary)

The development and practical application of remote controlled lining systems and equipment for restoring a perfect joint between a main sewer pipe and a lateral connecting pipe are reviewed, with particular reference to the HAM2 internal pipe rehabilitation unit. This has been developed by Preussag for use in conjunction with the Riblok system of spirally wound pipe linings. The various stages of the operation in the field are described, including the sealing of the internal surface using a thermosetting epoxy resin. The operation is controlled from a vehicle at the surface adjacent to the access manhole, and the integrity of the final lining confirmed with the aid of CCTV inspection and photography. Where circumstances dictate, a preformed GRP liner may be applied to the defective joint and sealed in place with the resin composition. (English translation, 215 pounds sterling, valid for 1995). **Germany**

95-0329

**Rehabilitation of sewer systems.**

D. STEIN (Ruhr-Universität Bochum)

*European Water Pollution Control*, 1994, 4, No 5, 49-56

The rehabilitation of damaged, defective and hydraulically over-charged sewers is important. A proposal for the planning, design,

construction and control of the rehabilitation process for existing sewerage systems is outlined. Hydraulic, environmental and structural rehabilitation are considered. Lining and coating methods are described and sewer renewal methods are outlined (open cut, trenchless methods: pipe eating, pipe bursting). Selection criteria for the different solutions are outlined. **Germany**

95-0330\*

**Asset management for underground networks: the operator's viewpoint.**

P. ACHARD (E. vonnasse des Eaux D'Ornez), P. CHANTRE and H. MADIEC

*HYDROTOP 94 Colloque Mieux gérer l'Eau, Marseille*, Vol. 2, 1994, 185-189 (in French, English summary)

As part of a project sponsored by the French Ministry of Transport concerning the quantitative risk assessment for failure of urban underground pipework (RERA) project, a study of the nature and causes of failure in certain parts of the Bordeaux sewerage system was performed, with particular reference to man entry sewers. Selected portions of these were subjected to a systematic internal inspection and the presence of defects noted. In addition the previous history of rupture or leakage from these sewers was analysed, and the data used to estimate the probability of failure in the future as a result of either ground conditions, hydraulic loading, structural problems and mechanical impact. In addition studies were made of the state of part of the distribution network for potable supplies, with similar objectives. The results achieved to date, and the level of agreement between the results of site investigations and the recorded incidence of failure or rupture of the network is discussed. **France**

95-0331\*

**Utilization of a database management system in the rehabilitation of sewer networks.**

Y. G. DIAB (Université de Savoie, Le Bourget du Lac), and B. SOLYRI

*HYDROTOP 94 Colloque Mieux gérer l'Eau, Marseille*, Vol. 2, 1994, 191-199 (in French, English summary)

The use of database management systems for the effective maintenance and renewal of sewer networks in French urban environments is discussed. Several alternative types of database are considered together with their implementation in practical terms. For this there are certain essential criteria, namely a thorough knowledge of the network, the difficulties encountered and the methods available to counteract them: the computerization of the inspection and recording procedures to ensure that data are available in an intelligible format, and the development of a databank which can be interrogated and subjected to different modes of analysis. Such databanks should include a variety of information pertinent to the surroundings, costs of installation and disturbance for replacement or repairs, in addition to the actual condition of the pipe, if they are to function as an effective tool for planning and decision making for sewer rehabilitation work. **France**

95-0332\*

**Sewer modelling for rehabilitation: a European project.**

D. M. DELAPLACE (Wallingford Software, U.K.), and R. KILLAGHER

*HYDROTOP 94 Colloque Mieux gérer l'Eau, Marseille, France*, Volume 2, 1994, 337-344 (in English)

The objectives of the SPRINT programme (Strategic Programme for Innovation and Technology Transfer) sponsored by the EC include a project entitled Application of Hydraulic Analysis to Sewerage

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Rehabilitation in Member States' the aim of which is to promote the use of the Wallingford Procedure for the hydraulic analysis of sewerage networks by other EC member countries. The nature of this system of hydraulic analysis is reviewed, comprising 3 principal parts namely the modified rational method, the hydrograph method and the simulation method, together with the activities proposed within the context of SPRINT to implement these methods in other countries and ensure dissemination of the results. In this connection the salient features of 3 pilot studies in Ireland (Dublin), France (Marseille) and Italy (Milan and Rome) are described from which data concerning the validity of the procedures in these countries will be obtained, as a basis for the further dissemination and transfer of the methods. **Europe**

95-0333

### Urban sewerage rehabilitation in the UK.

R. HURLEY (WRc Medmenham)

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 4, 425-431

The history of sewerage rehabilitation in the U.K. and development of the Sewerage Rehabilitation Manual (SRM) are reviewed. The SRM planning procedure is described in detail and experiences of implementation since 1984 are presented. Effects of changes in the water industry including the Water Act 1989, the New Roads and Street Works Act 1991 and a proposed European standard are considered. The present status of rehabilitation is discussed and the benefits arising from the SRM are identified. **U.K.**

95-0334

### Florida contractor sliplines first rehab project.

A. THOMAS

*Trenchless Technology*, 1994, 3, No 8, 35

The Eastern Rehab project, part of the 2.8 million U.S. dollar rehabilitation project in Lakeland, Fla., was being carried out by Kimmings Contracting Corp. of Tampa, Fla. Following detailed video inspection of the small and large diameter pipes, Lampoon Nylon slipliner pipe was selected for the rehabilitation of 12,623 ft of wastewater collection system. Factors influencing this choice are outlined. The joining system used on the Nylon pipe was a gasketed push on coupling that met the requirements of ASTM D3212 and slid between the inner and outer walls of the pipe. The ability to make field cuts also proved beneficial where shorter sections of pipe were needed. Following the sliplining, the annular space would be grouted. Started in April 1994, the project was expected to take 9 months to complete. **U.S.A.**

95-0335

### Manhole rehab business is down the hole.

B. P. KRZYŚ

*Trenchless Technology*, 1994, 3, No 8, 42-43

Work carried out by AP/M Permaform in manhole rehabilitation is described. More than 3000 manholes in the U.S.A., Canada and the Caribbean had been successfully rebuilt by the company or its licensees since 1987. The Permaform system was a fully structural repair system that could be carried out completely without any excavation. The recently developed Perma-cast was a centrifugal applied synthetic cementitious liner, cast from a patented robotic applicator positioned in the centre of the manhole. A dense uniform layer was compacted in place at any thickness from 0.15 to 2 inches depending upon the extent of deterioration and the depth of the manhole. The two systems were designed to be complementary, but

could also be used together, as illustrated by a recent project in Wisconsin, U.S.A.

95-0336

### Priority pollutants from urban storm water runoff into the environment.

C. XANTHOPOULOS (Universität Fridericiana zu Karlsruhe),

and H. H. HAHN

*European Water Pollution Control*, 1994, 4, No 5, 32-41

The concept of urban drainage systems via separate and combined sewers is examined to determine whether it meets the requirements posed by storm water runoff. Micropollutants in urban drainage systems are considered: undissolved solids, organic oxygen demanding substances, bacteriological pollution, nutrients, heavy metals, PAH, volatile chlorinated hydrocarbons, herbicides, dioxins. Pollutant sources and potential sinks in urban drainage systems are discussed. The effects of using storm water runoff for irrigation and specific domestic purposes are discussed. The present uncontrolled loading of treatment plants and storm water basins causes reduced effectiveness of these treatment units. Present day systems could be improved by reducing pollutant emissions and total runoff, reducing the mixing of differently polluted runoff components, and the immediate return of unpolluted runoff components into the natural hydrological cycle, specific treatment of more polluted runoff components, real time operation of the sewer system, and controlled loading of all units for storm water and wastewater treatment. **Germany**

95-0337

### Deterministic versus stochastic interpretation of continuously monitored sewer systems.

P. HJERREMOES (Danmark Tekniske Højskole Lyngby) and J.

C. CARSTENSEN

*European Water Pollution Control*, 1994, 4, No 5, 42-48

Deterministic modelling of rainfall runoff in sewers had achieved remarkable success but no result is more accurate than the accuracy of the input data. The uncertainty of input parameters of deterministic models for sewer systems is considered with respect to rainfall data. Stochastic models have the potential for dealing with uncertainties. The characteristics of stochastic models are outlined and the stochastic modelling approach is illustrated using data from the Damhusaen catchment drainage system, Copenhagen. Modelling flow from water level, the base flow, rainfall runoff hydrographs, rain flow using a transfer function are considered. The concept of grey box modelling is examined. **Denmark**

95-0338

### Dimensional design of retention tanks.

P. KAUFMANN (VET AG Bern), D. LIENER, F. BAER

*Gas Wasser Abwasser*, 1994, 74, No 8, 684-690 (in German)

(English summary)

Retention and infiltration systems for stormwater are becoming more prevalent in the development of urban drainage systems and neighbourhood planning. With the aid of digitized information concerning heavy rains, it is possible to derive appropriate guidelines for calculating the storage capacity required and the application of the SASUM software for computation of retention volumes in typical situations is outlined. The programme enables the rainfall events for a test catchment to be simulated, based on a historic series covering the 50 years from 1928 to 1978. Rates of runoff ranging from 5 litres per second to 120 litres per second ha of paved surface were predicted and the necessary storage volumes for storms with return

periods ranging from 1 to 10 years were calculated. (English translation 150 pounds sterling, valid for 1995). **Switzerland**

95-0339

**Even brake.**

*Water & Environment International* 1994, 3, No 30, 34-35.

A Conderbrake stormwater balancing system was installed in a residential development on the site of an aquifer when roof and roadway drainage to soakaways was forbidden to protect water resources. The system combined a separator with a drainage management system based on a concept which harnessed natural vortex phenomena to provide cost effective and efficient balancing. This was achieved by dividing the unit with a weir baffle equipped with two non return flap valves and which incorporated the vortex flow controller. The system allowed a larger outlet diameter, thus minimizing the possibility of blockages while reducing storage requirements. This system enabled the developer to acquire full planning permission for the development. **U.K.**

95-0340

**Method predicts CSO treatment efficiency**

STEELE, ALEXANDER (Wade Trim Associates, Taylor, Mich). *Water Environment & Technology* 1994, 6, No 9, 23-24.

Investigations are reported from Detroit, Mich., into the feasibility of predicting the performance of retention basins for the settlement of solid particles in combined sewer overflows. The host of variables to include the proportion of storm flow to municipal overflow, particle size and specific gravity of the particles they each contain, and the duration and intensity of the storm hydrographs in the catchment area, is varied. It is planned to build 3 basins, which should be in operation by 1998, in catchments with different wastes in flow. A characteristic monitoring programme will then be undertaken to determine these characteristics at the influx to the basins. From these, a final performance will be measured against that predicted from Stokes Law. Examples of the application of this law, in terms of the settling velocity of particles of a specific diameter and gravity, on which the design of the basins will be based, are given, and a design relating these to the flow rate is offered. The investigations show that any refinement of this curve is needed. **USA**

95-0341

**Pump station serves stormwater detention chambers**

*Water Works* 1994, 125, No 10, 93-94.

Major drainage improvements, including an underground detention vault, had been carried out to solve a long term flooding problem along the North Central Expressway in Dallas. The existing drainage vault had been replaced with a new 7.5 mile long structure with vault sizes up to 18 ft in diameter. The detention vault had been constructed by mining in the subsurface Austin chalk. Off line side channel detention was chosen to allow the lower part of the flow hydrograph to bypass the detention facility, thus lowering storage volume requirements. The pump station employed 4 submersible propeller pumps to discharge stored water to the bypass tunnel. System construction and pump installation is described. **USA**

95-0342

**Point of interest**

*Ground Engineering* 1994, 27, No 7, 14-15.

An innovative alternative design for the new sea outfall at Lavernock Point in south Wales was saving some 20 per cent on construction costs. The 1.15 km long outfall was being assembled and jacked out to sea from land, into a pre excavated 6 m deep, 4.5 m wide trench

in up to 25 m of water, to overcome problems of high tidal ranges and extreme weather conditions. The outfall consisted of a 1000 m long, 1.9 m outside diameter butt welded steel pipe with a 250 m long, 15 riser diffuser section at the seaward end. Low porosity reinforced concrete was cast around the pipes to provide dead weight and protection from aggressive seawater. The steel pipe was also coated internally with a hard enamel paint and externally with a layer of bitumen, with additional cathodic protection to give an 80 year design life. Trench excavation and pipe jacking is described. Excavated materials would be carefully lowered back around the new outfall once it was in place. **U.K.**

95-0343

**Clean beach at Brighton**

A. J. MILLER (Acer Consultants Ltd). *World Tunneling* 1994, 7, No 7, 273-7.

The Brighton and Hove stormwater project, Operation Seaclean, was designed to prevent overflows occurring during heavy rain from sewer outfalls along the beach and help meet compliance with the EC Bathing Water Directive. Following feasibility studies and hydraulic modelling, Acer Consultants were commissioned by Southern Water Services Ltd. to design, construct and site manage the project. Stormwater from the outfalls would be intercepted through 4 drop shafts, connected by stub tunnels to a parallel tunnel driven below the beach. The stormwater would be stored until it could be pumped back into the interceptor sewer at the eastern end. The project was an O&M (Green Book) design and construct contract awarded to Taylor Woodrow Civil Engineering. Tunneling work using TBM and pressure balance machines is described together with grouting procedure. **U.K.**

95-0344

**Two-dimensional simulation of basin irrigation. I: theory**

EL PLAYAN (Servicio de Investigacion Agraria, Zaragoza), W. R. WALKER and G. P. MURKLEY.

*Journal of Irrigation and Drainage Engineering* 1994, 120, No 5, 837-856.

A 2 dimensional model (B2D) developed for basin irrigation employed the leap frog finite difference technique to solve the partial differential equation that accounted for continuity of momentum in the x and y directions and continuity of mass for corner, linear and fan inflow boundary condition, and the initial conditions of level basin irrigation. A numerical test demonstrated that the predicted time of advance approached an asymptotic value as the grid became smaller but the effect was greater for quasi 1 dimensional than for 2 dimensional simulation. Finer grids also reduced the final values of mass balance error. The proposed model was validated by 2 field experiments which showed that under 2 dimensional conditions B2D and the 1 dimensional mode, SRMOD under estimated time of advance by 7.9 and 1.5 per cent respectively, only B2D approximated the trout configuration (see also following abstract). **Spain**

95-0345

**Two-dimensional simulation of basin irrigation. II: application.**

EL PLAYAN (Servicio de Investigacion Agraria, Zaragoza), W. R. WALKER and G. P. MURKLEY.

*Journal of Irrigation and Drainage Engineering* 1994, 120, No 5, 857-876.

Two hypothetical case studies are presented to illustrate the ability of the 2 dimensional level basin irrigation model B2D to accommodate multiply inflow configurations and irregular fields that included

## SEWAGE

high spots (islands). Analysis of the irrigation performances for rectangular fields of different shape with a corner inflow showed that advance times increased as the field shape approached a square and could be underestimated by up to 20 per cent by 1 dimensional models. The use of a 2 dimensional model was justified when the aspect ratio between the width and length of the field reached 0.4. In a hypothetical case study involving the design of a basin irrigation system in a 10 000 m<sup>2</sup> square field spatial variability of infiltration was responsible for differences of approximately 10 per cent in application efficiency and 20 per cent in distribution uniformity and B2I identified those configurations that produced more efficient and uniform irrigations. These results demonstrated the advantages of using a 2 dimensional model to design basin irrigation systems (see also preceding abstract). **Spain**

95-0346

### Method for estimating efficiency in Spanish irrigation systems

W. KRINNER (Centro de Estudios y Experimentación de Obras Públicas, Madrid), A. GARCIA and F. ESTRADA

*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 5, 979-986

Information about 45 irrigation systems in 8 large river basins was obtained from technical data files and national agricultural surveys and there was a general lack of reliable data, particularly flow data. Estimation of conveyance efficiency in 5 systems with adequate data indicated that conveyance losses were at least 10 per cent of the released volume. The upper limit of global efficiency was calculated for 38 systems (representing 20 per cent of the total irrigated surface area in Spain) by comparing the theoretical crop water requirement with volume released at the head. Net demand/release ratios ranged from 0.54 in 29 zones where gravity irrigation methods predominated to 0.80 in 9 zones with pressure irrigation where water losses during distribution and application were lower. High ratios were also associated with relatively new irrigation systems, low annual gross supply and water charges based on the volume consumed. **Spain**

95-0347

### Air entrapment and water infiltration in two-layered soil column.

H. LAHFI (Memphis State University, Tenn.), S. N. PRASAD and O. T. HILLIG

*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 5, 871-891

A laboratory study to investigate 1 dimensional unsaturated water infiltration used vertical columns of homogeneous or 2 layered soil to identify wetting front movement. Analysis of air and water pressure development showed that air pressure build up was more pronounced in 2 layer soil columns. An experiment to determine the influence of air pressure on water profile development showed that the water content in the upper layer of the 2 layer column exceeded that in the upper part of the homogeneous 1 layer column. In the sealed 2 layer column the increased air pressure of the bottom layer retarded the non uniform wetting front, thus enhancing wetting of the top layer until pressure in the bottom layer reached a maximal value. An analytical model developed to predict cumulative infiltration into the top layer and travel time of the wetting front showed good agreement with laboratory results and a numerical example is presented. **U.S.A.**

95-0348

### Modelling regional flow and flow to drains.

G. M. POHLL (Nevada University, Reno) and J. C. GUITJENS

*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 5, 925-939

In an investigation into the feasibility of using drainage water for irrigation the transient 2-dimensional finite difference flow model MODFLOW was used to simulate the hydraulic head distribution and advective velocity vectors in an agricultural field with 15 tile drain laterals for 20 d after a flood irrigation event. Installation of 78 piezometers at various depths enabled model parameter estimation and calibration. The results indicated there was mixing of irrigation water with shallow groundwater and the initial significant downward flux of water after the irrigation event was replaced in time by a dominant horizontal flow component and subsequently a dominant regional flow with some upward flow from a point 1.0-1.5 m below the drain laterals. The downward water flux was at least an order of magnitude greater than the upward and lateral fluxes resulting in a net downward flux of irrigation water during the irrigation season. **U.S.A.**

95-0349

### Hydro projects in China.

G. PIARS (U.K.)

*World Tunneling*, 1994, 7, No 7, 287-292

The principal rivers and their potential for hydroelectric power generation in China are discussed. Hydroelectric power stations that have been or are under construction are summarized. The following new projects are described: Three Gorges, Longtan, Xiaolangdi, Manwan, Xiaowan, Ertan, Shuikou and Transhengqiao I and II. The following pumped storage projects are also discussed: Guangdong Shisanling and Yamaho Yumico. Future potential and planned projects are also considered. **China**

## SEWAGE

95-0350

### Optimized contracting methods in the public sector and turnkey projects for sewage treatment plant construction

A. KLEIN (Abwasser Verband Saar, Saarbrücken)

*Abwassertechnik*, 1994, 45, No 4, 12 and 14 (in German)

Some of the problems connected with the preparation and agreement of contracts in the public sector are discussed with reference to the erection of sewage treatment plants and the experience of the Abwasser Verband Saar (AVS) in optimizing and streamlining procedures for specification, tendering and contract documentation is reviewed. The advantages of adopting the turnkey project system are discussed, with particular emphasis on the benefits associated with the fixed price, shorter overall duration of the period from conception to realization, and the greatly reduced workload for the client organization. Some of the essential prerequisites for the turnkey project route are outlined, followed by a brief account of recent experience of this method within the AVS (English translation 105 pounds sterling valid for 1995). **Germany**

95-0351

**A new procedure for upgrading sewage treatment plants.**

H. F. van der ROEST, H. M. JANUS, R. L. van der KUIJ, and F. J. GIGERS.

*Abwassertechnik*, 1994, 45, No 4, 40 and 43-44 (in German).

Due to the more stringent stipulations of the EC Directive with respect to nutrient removal from treated sewage discharges, many of the existing sewage treatment plants in The Netherlands are in need of upgrading. In some cases there is insufficient space for plant extensions of the conventional type, and in any case these represent an expensive method of solving the problem. Alternative measures are therefore proposed for optimizing the operation of the plant, coupled with the introduction of novel auxiliary processes of either a biological, physical or chemical nature. Some examples of these are given such as the use of technically pure oxygen for enhancing the performance of the biological treatment stages, and the use of chemical precipitation or air lift reaction systems for the treatment of sludge liquor. Plants for ammonium recovery using either chemical coagulation with magnesium phosphate, or air stripping and reacidification with sulphuric acid are undergoing trials. For optimizing the performance of the modified plant the operation of dynamic computer simulation programs is an effective tool, based on the latest version of the comprehensive UCT model developed originally at the Cape Town University. Two typical examples of sewage treatment plant upgrading using these methods, at Kralingsveer and Utrecht, are described. (English translation, 150 pounds sterling, valid for 1995. Netherlands)

95-0352

**Combined biological treatment of municipal and slaughter-house effluents in Thüringia.**

U. ABELING, A. KRAFT, and V. MAHLE.

*Abwassertechnik*, 1994, 45, No 4, 66-68 (in German).

A new sewage treatment plant was required to serve a small collective sewage undertaking with only 5000 PE, together with a new vegetable and meat processing factory with an estimated effluent volume of 27 000 PE, coupled with further trade premises to be erected later, with a possible contribution of 15 000 PE. A collaborative design partnership, with the assistance of the WABAG Leipzig was responsible for the erection of the plant, which employed 2 parallel crousel systems, each with 4 preliminary anaerobic compartments, for phosphorus removal as the biological treatment stage. In view of the lack of experience in treating effluents originating from the meat factory, operation was entrusted to a private contractor, namely WABAG Kulmbach, in partnership with Severn-Trent Water. Start-up took place in July 1993, with effluent arising solely from the meat factory; the introduction of municipal sewage commenced in January 1994, and no input from the other trade premises has occurred to date. A description of the plant operation and treatment performance is presented with data showing the quality of the incoming sewage, and the removal efficiencies obtained with respect to various organic and nutrient parameters to date. At present, the plant is operating at less than half its rated hydraulic capacity, and roughly two thirds of the planned organic loading, due to the preponderance of the effluent from the meat factory. Treatment efficiencies in terms of COD removal improved once the supply of readily degradable municipal sewage commenced. (English translation, 135 pounds sterling, valid for 1995. Germany)

95-0353

**SAFE sewage technology-the Par experience.**

J. ALDRIDGE (PWT Projects Ltd).

*Filtration & Separation*, 1994, 31, No 6, 587.

The Par works, which came on stream in June 1994, is one of the first of a new generation of compact plants, and utilizes secondary stage biological aerated flooded (BAF) filter technology in place of aeration tanks or percolating filters. The works at Par is one of the largest BAF plants in the U.K. and serves a population of 50 000. It can handle a peak flow of 300 litres per second, with a dry weather flow of 150 litres per second, and the final effluent meets the standards of 25 mg BOD per litre and 35 mg suspended solids per litre. The SAFE (submerged aerated filtration) process occurs within the filters, and is an attached growth system in which micro organisms (activated sludge) grow on a submerged inert support medium having a particle size of less than 5 mm. U.K.

95-0354

**Process optimization by advanced data handling.**

C. NICKELSEN (Water Quality Institute, Science Park, Aarhus).

A. LYNGBAARD-JENSEN, P. BALSLEV, H. P. HANSEN, J. D. NIELSEN, L. K. SØRENSEN, and P. ØIESEN.

*HYDROTOP 94, Colloque Microgeres/L'air, Marseille.**France*, Volume 2, 1994, 1-28 (in English).

The design and performance of the DOPA (Dynamic Operation Regulation and Analysis) system for the multilevel operational control of the sewage treatment plant at Herning are described. Both the hardware and software configurations are discussed, comprising the 3 levels of data acquisition, data processing and process control functions. The mode of operation in each case is explained and the performance of the control functions is illustrated with reference to the coagulant dosing system for phosphorus removal, and the operation of the gravity filtration plant, including chemical addition, cycle time, and backwashing, mode. Primarily showing the system response as a function of time, to illustrate the extent to which the process could be optimized despite fluctuations in input parameters, are reproduced. Denmark.

95-0355

**Expert systems as an aid to plant operation: experience at Marquette Léz-Élle.**

J. P. DUNYS (Communauté Urbaine de Lille), D. RIANT, J. C.

BRIGÉ, C. LAYOUX, and P. CHATELIER.

*HYDROTOP 94, Colloque Microgeres/L'air, Marseille*, Vol.*ume 2*, 1994, 69-80 (in French).

The nature of the expert system, code named EGANT, for representing the behaviour of the Marquette municipal sewage treatment plant at Lille, both in quantitative and qualitative terms, is described. In the operation of this system, a diagnostic tool for identification and correction of the cause of plant malfunctions is reviewed. The method proved to be invaluable in providing solutions and options for improving plant performance in the event of deviation from expected behaviour, and is capable of predicting the response of biological processes, the hydraulic behaviour and even some of the unpleasant sensory effects such as foul odours and other conditions which result from certain undesirable combinations of physical and biological variables (e.g. septicity, abnormal sludge index values and oxygen deficiency). France.

## 95-0356\*

### Improving availability at sewage treatment plants to guarantee their performance.

J. P. OLLIVIER, HENRY (Contrôle et Prévention Toulouse)  
*HYDROTOP 94 Colloque: Mieux gérer l'Eau - Marseille*, Vol. 2, 1994, 93-100 (in French).

An investigation was carried out into the availability of the various items of plant and equipment essential to the operation of the Ginestous sewage treatment plant, which comprised 2 parallel treatment chains with rated capacities of 400,000 and 150,000 PE. The causes and the duration of shutdown periods occurring during a period of 12 months were identified to determine whether the prescribed level of compliance with performance standards specified in the EC Directive 91/271/EEC was being achieved, which stipulates that the effluent quality criteria must be adhered to for 95 per cent of the time. The results of the survey showed that the plant availability level of 83 per cent was considerably below the prescribed figure. It also identified the causes of failure to meet the performance targets associated with failure of power supplies, mechanical breakdowns or loss of biomass due to wash out. The lengths of the downtime required for repair in replacement of certain mechanical parts indicated a need for more attention to be given to accessibility for repair and availability of spare parts when designing a treatment facility.

France

## 95-0357\*

### Automation of the treatment plants.

N. VERNESONI (Provincia Autonoma di Trento)  
*HYDROTOP 94 Colloque: Mieux gérer l'Eau - Marseille*, Volume 2, 1994, 498-503 (in English).

The province of Trento, through its Sanitary Engineering Department, controls the operation of 65 sewage treatment plants situated in various parts of the district of Trentino, a mountainous area of 6500 km<sup>2</sup>. The treatment plants have design capacities ranging from 500 to 100,000 PE, the 2 largest of which serve the towns of Trento and Rovereto. A remote control system for the centralized operation and management of these plants has been developed over the last 9 years, culminating in the HEDDI integrated control system which has been operational for the last 2 years. The architecture, hardware and performance features of this system are reviewed. It incorporates a remote supervision facility which can be connected to any treatment plant for the purpose of checking the state of operation of specific parts of the plant, while the data can be stored at the central control point for further analysis and control decisions. The centralization of the data storage and handling systems enables the operating data fields to be updated automatically at night by a modem connected to the public telephone system. The system provides, in addition to numerical data, a visual display of the state of each treatment plant, in real time, underlining possible anomalies, as a basis for corrective action if necessary.

Italy

## 95-0358

### Gearing for the future...how push-button simplicity helps treatment plant.

B. D. HILD (Crawford, Murphy & Lilly Inc., Springfield, Ill.)  
*Public Works*, 1994, 125, No 10, 70-71.

The new wastewater treatment works in Greenville, Ill., utilized post lime stabilization prior to sludge disposal to comply with the new U.S. EPA 40 CFR Part 502 regulations. This process stabilized sludge by adding quicklime to sludge that had been dewatered on a belt press. The activated sludge treatment works incorporated a three channel oxidation ditch activated sludge system, designed to

achieve complete nitrification. The facility could produce either Class A or Class B sludge with only a few minor operating modifications. Facility design and construction is discussed.

U.S.A.

## 95-0359

### Advanced primary treatment: a positive alternative for New York's Owls Head plant.

J. J. CHACK (Metcalf & Eddy, New York), V. RUBINO, R. FLORENTINO, P. J. KRASNOFF, and J. LIUBICICH  
*Public Works*, 1994, 125, No 10, 80-82.

Factors influencing the selection of treatment processes for the upgrading of New York's Owls Head wastewater treatment works are examined. These included the mandated use of coagulants to enhance removals of primary suspended solids and BOD. Criteria for the choice of coagulant type and dosage are outlined. Plant scale tests that were carried out to evaluate coagulation processes using metal salts and polymers as coagulants are described. Coagulant dosages were also identified together with polymer feed location and dosages for wet and/or cold weather flows. Operating costs and effluent limits for polymer and ferric chloride coagulants are discussed.

U.S.A.

## 95-0360

### Poole cover

L. STEDMAN

*Water & Environment Management*, 1994, No 19, 18-19.

Upgrading of Poole's sewage works was needed to meet Urban Waste Water Directive standards and population increases. A lamella and 2 stage biological aerated filter system, for a population equivalent of 91,000, was chosen. The inlet works was a fully enclosed system. Odour treatment was provided by 2 wet chemical scrubbing towers using sulphuric acid and sodium hypochlorite. Unusually high ammonia concentrations in the effluent necessitated the use of a 2 stage Biofor system with ammonia removal.

U.K.

## 95-0361

### Plant overcomes space restrictions.

F. N. PLATT (Killam Associates, Millburn, N.J.)

*Water Environment & Technology*, 1994, 6, No 9, 47-48.

The upgrading of a sewage works in New Jersey to standards for phosphorus and ammonia levels in effluents called for by the State's Department of Environmental Protection is described. The works occupied a confined site, adjacent to a designed wetland on one side and a residential area on the other. Expansion into either was firmly discouraged. The works opted to secure the phosphorus and ammonia reduction required via an activated sludge system, the phosphorus being taken up in an anaerobic/aerobic sequence. The original primary settling tank was dispensed with; the contact stabilization basins were converted into the anaerobic and aerobic reactors; solids holding tanks were partially covered to permit the construction of additional facilities on a second storey; and gravity belt thickeners were installed above existing tanks. The works still needed to take a small parcel of land from the wetland, but the configuration of the new unit processes permitted it to dispense with an acreage more than equivalent, this joining up with existing lands to form a more valuable wetland whole.

U.S.A.

95-0362

**Odour control systems for waste water treatment plant.**

C. D. ERG (Air Pollution Control Ltd.)

*Water & Waste Treatment* 1994, 37, No 9, 14-15

Sources of odours at wastewater treatment works are ascribed to formation of hydrogen sulphide, mercaptans, ammonia and amines. Three ways of eliminating such odours, activated carbon adsorption, biological processes and chemical adsorption scrubbing, are outlined. Advantages and disadvantages of each process are identified. U.K.

95-0363

**Controlling smells at Slough.**

K. DAVIES (Costain Environmental Services Ltd.)

*Water & Waste Treatment* 1994, 37, No 9, 18 and 20

Construction is reported of a peat and heather biofilter at Slough wastewater treatment works. Aeration tanks, inlet channels, sludge sumps, centrifuge and centrate tanks were enclosed and foul air discharged after passage through the biofilter. Moisture content of the media was maintained by the water present in the foul air, although an irrigation system was installed. Life expectancy of the peat is 2 to 5 years and mature heather was included to maintain the open structure. Equipment installed for incineration of methane produced, screening, storm flow, centrate handling and aeration are briefly described. U.K.

95-0364

**Researching the source of smells**

A. BOON (Acet Environmental) and L. ANDERSON

*Water & Waste Treatment* 1994, 37, No 9, 23-24

Sources and types of odours at sewage treatment works are summarized. Methods of control are discussed including preventive measures, use of bactericides, containment strategies and treatment option. Development of a mathematical model to assess use of sensors is reported briefly. U.K.

95-0365

**Sewage treatment and sludge treatment operations in Great Britain**

F. F. CLARK

*Abwassertechnik* 1994, 45, No 4, 46-48 and 80 (in German)

A general account of recent changes in the organization and management of sewage collection and treatment in the U.K. is given following the implementation of the Water Act 1989 and other legislative measures concerned with the control of pollution and compliance with EC Directives in the water quality field. Progress in reducing the numbers of pollution incidents following the introduction of more intensive monitoring by the National Rivers Authority, together with proposals for substantial capital investment in sewerage systems and sewage treatment plant are summarized, while the methods employed for sewage treatment are discussed and some specialized systems designed to eliminate industrial residues or to achieve particular treatment goals are described including those at St Albans, Tilbury, Leek and Pittington. Efforts devoted to the upgrading of sewerage networks and more effective treatment of stormwater are also outlined followed by a review of trends in the treatment and disposal of sewage sludges in view of the imminent ban on the disposal of sewage sludge by dumping at sea. Other developments connected with the use of biogas as a source of energy and the operation of electricity generating plant are also considered together with the general legislative framework for pollution control

measures affecting air, water and soil environments. (English translation 195 pounds sterling, valid for 1995). U.K.

95-0366\*

**Analysis of operating reliability of a sewage treatment plant run by programmable computers.**

J. P. DENYS (Communauté Urbaine de Lille) and J. P. RAOUL

*HYDROTECH 94: Colloque: Mécanique et Eau: Marseille*, Vol. 2, 1994, 77-84 (in French)

As a basis for the award of a contract to construct a new centralized sewage works for the Armatures Communes sewerage network lying to the west of the Lille urban area, a proposal for a packaged deal was envisaged which involved the building of the plant and its operation during the next 20 years. To investigate the suitability of the plant configuration proposed in the face of the expected fluctuations in flow rate and pollution loading, together with the consequences of unforeseen events such as mechanical breakdowns, a model of the proposed system of the Markovian type was devised by means of which an analysis of the consequences of possible future breakdowns could be performed. The way in which such a model can be used to indicate possible deficiencies in the control system is considered, followed by an view of the additional warning and alarm systems found to be necessary in view of the model predictions. France

95-0367

**Comprehensive fate model for metals in municipal wastewater treatment**

W. T. PARKER (Envirolog Ltd, Hamilton, Ont.) and D.

MONTEITH, J. P. BELL, H. MEYER, and P. M. BERTHOUD, *Journal of Environmental Engineering* 1994, 120, No 5, 1-66, 1984

A revised version of the TOXCHEM model was used to predict the fate of metals in municipal wastewater treatment. The model was calibrated using experimental data obtained by a titration technique and evaluated using data from 5 Ontario wastewater treatment systems. A goodness of fit test showed that predictions of copper and zinc effluent concentrations at 15 locations lay within the confidence limit defined by the variability of field data. Poor fit of some predictions was attributed to the introduction of low concentrations and a lack of model calibration. More accurate predictions were achieved if the model was calibrated at specific treatment facility. Canada

95-0368

**The Chesapeake bay plan: restoring an estuary in distress**

P. E. WORTHEN (S. Inhaber Corporation, Elmsville, Ala.)

*Water Engineering & Management* 1994, 141, No 9, 18 and 21-22

The background to the pollution of Chesapeake bay and measures to restore it are briefly reviewed. Nutrients were the most significant pollutants. A number of wastewater treatment plants had been upgraded to include a counter current aeration system which was energy efficient and facilitated biological nutrient removal. Air diffusers were mounted on a rotating bridge above a circular basin. The bubbles were spread efficiently across the tank and their rate could be controlled to provide different oxygen levels. Phosphorus removal of 41 and 16 per cent from point and diffuse sources respectively had brought about significant improvements. Examples of the successful application of this system are given. U.S.A.



95-0369

## Evaporation: a wastewater treatment alternative.

I. M. PANKRATZ (Aqua Chem Inc., Dubai)

*Water Engineering & Management*, 1994, **141**, No 9, 42-47

Evaporation as a method of concentrating wastes or recovering water is discussed. Energy efficiency was improved by multiple effect evaporators so that heat from the steam in an earlier unit was available for subsequent units. Vapour compression was another method of conserving heat. Vertical tube falling film, horizontal tube spray film, forced circulation, combined and hybrid systems were common evaporator types. Evaporators were applied to difficult wastes to achieve zero discharge and contribute to water re-use. Some costs are provided. **United Arab Emirates**

95-0370

## Long-term experience with the Schattweid wetland plant sewage treatment system.

A. SCHONBORN (Zentrum für angewandte Ökologie

Stenhusenberg) and B. ZUST

*Umwasser Abwasser*, 1994, **74**, No 8, 674-683 (in German, English summary)

Since autumn 1985 the domestic sewage originating from the Centre for Applied Ecology at in the canton of Lucerne has been treated in a small artificial wetland system. The wastewaters are principally composed of grey water from washing, cooking, bathing and shower facilities together with laboratory and urinal wastewaters. These are treated in a small system comprising a settling tank, a sand filter and a planted soil filter connected in series. Studies of the effluent quality indicated that a 95 per cent BOD removal, 89 per cent COD removal and 91 per cent ammonium nitrogen removal percentages have been achieved, while 89.5 per cent of total phosphorus was also retained. The biological conversion of nitrogen compounds improved appreciably during the period of operation. Various aspects of plant operation, including water balances (allowing for rainfall), seasonal variations in treatment performance and changes in species composition of the vegetative cover are discussed, together with possible implications for the future of such installations. (English translation 240 pounds sterling, valid for 1995). **Switzerland**

95-0371

## Short circuiting and density interface in primary clarifiers.

S. ZHOU (Windsor University), J. A. MCCORQUODALE and A. M. GOUD

*Journal of Hydraulic Engineering*, 1994, **120**, No 9, 1060-1080

Two versions of a numerical model were used to simulate the unsteady flow pattern due to thermal short circuiting and a density interface in a rectangular settling tank in which a warm influent entered under a reaction bottle. The model consisted of a series of conservation equations for fluid mass, momentum and temperature, and employed either the algebraic stress turbulence model or the conventional turbulence kinetic energy turbulence dissipation rate model. Laboratory measurements of velocity and temperature profiles in thermal density currents produced by discharging warm water into an initially cold ambient fluid indicated that the numerical model generally captured the flow pattern features. Values predicted by the algebraic stress turbulence model were in good agreement with measured values and a proposed intermediate level model combined the generality of a second order closure scheme with computational economy. There are 38 references. **Canada**

95-0372

## Comparative appraisal of activated sludge and fixed-bed processes for biological treatment of sewage.

H. KROISS (Technische Universität Wien)

*Abwassertechnik*, 1994, **45**, No 4, 51-56 (in German)

A comprehensive discussion of the respective characteristics of suspended biomass and fixed film reaction systems for the treatment of sewage is presented. The recent revival of interest in fixed film systems has been occasioned by their particular advantages in allowing slow growing microbial flora to develop, especially those involved in the nitrification process, together with their compact design and good sludge settling and removal performance. The factors conducive to successful operation of fixed bed reaction are reviewed, involving considerations of the mass balance (carbon/nitrogen ratio), aeration and oxygen requirements, selection pressures, kinetics and the limitations of diffusion controlled reactions. Several alternative types of fixed film bioreactor are also discussed, such as trickling filters, rotating biological contactors and biological filters and fluidized bed systems. The manner in which the performance of these systems is affected by the system design, composition of the liquid and residence time of the liquid and solid phases is considered together with the effect of ambient conditions such as temperature and the mixing conditions within the reaction compartment. The economic factors such as space and capacity requirements are also briefly discussed. (English translation 330 pounds sterling, valid for 1995). **Austria**

95-0373

## Effects of ionic strength on bacterial adhesion and stability of flocs in a wastewater activated sludge system.

A. ZHANG (Göteborg University) and M. HILFMANSSON

*Applied and Environmental Microbiology*, 1994, **60**, No 9, 3041-3048

Tests on 20 activated sludge samples obtained from a municipal wastewater treatment plant during 1 year showed that floc stability increased with increasing ionic strength of the medium. Increased floc strength was attributed to compression of the electrical double layers around all surfaces due to increasing electrolyte concentration. However floc stability decreased at ionic strengths above 0.1 and the increased turbidity due to the release of free cells could not be explained by ion exchange mechanisms. In reflocculation experiments rebuilding of dissociated flocs was observed after the addition of potassium chloride or calcium chloride, thus demonstrating the reversibility of the electrostatic double layer effect. Floc stability in wastewater treatment systems could be affected by the influent ionic strength. There are 32 references. **Sweden**

95-0374

## Biological treatment of effluents from physico-chemical treatment centres.

S. THEIDINGSFELDER (Forschungs- und Entwicklungszentrum

Sondermühl, Schwabach), D. SEETHALER and H. D.

ROHMERMANN

*Korrespondenz Abwasser*, 1994, **41**, No 9, 1558-1560 and 1562-1563 (in German, English summary)

Laboratory and pilot scale trials were performed on the biological treatment of effluent from a disposal centre for special wastes at Schwabach, where the concentration of salts and nitrogen compounds varied widely and could reach elevated levels. A multi stage treatment system incorporating first and second stage activated sludge compartments with additional provision for denitrification was employed, and effluent from the physico-chemical treatment

plant for highly contaminated waste was combined with the leachate from the remainder of the disposal site in various proportions prior to treatment. The results demonstrated that a high degree of nitrification and elimination of organic matter (BOD5/COD) could be achieved in the presence of considerable proportions of the salt-bearing liquor, amounting to more than 50 per cent of the total, but as the volume of this liquor represented only around 20 per cent of the effluent generated at the plant, a lower ratio would be adequate for practical purposes. For higher proportions of the liquor in the intake to the biological treatment plant, careful monitoring of nitrite and nitrate concentrations in the final effluent would be advisable. (English translation 165 pounds sterling, valid for 1995). **Germany**

95-0375

#### Oxygen utilization of trickling filter biofilms.

S. W. HINTON (Tufts University, Medford, Mass.) and H. D. STENSEL

*Journal of Environmental Engineering*, 1994, **120**, No. 5, 1284-1297

A methodology was developed to study trickling filter oxygen consumption rates in a section of cross-flow media in operating conditions representative of COD and hydraulic loadings typically used with this type of treatment system. The effects of COD and hydraulic application rates on the oxygen consumption rate were studied. The resulting data were used in the development of a mechanistic model describing oxygen and substrate utilization in a trickling filter. Oxygen consumption rates increased with increasing influent substrate concentrations at COD concentrations in the range 40-120 mg per litre and remained relatively constant with higher influent substrate concentrations. **U.S.A.**

95-0376

#### Conversion of a trickling filter plant for nitrogen removal, with reference to the Sundelfingen sewage works.

H. MAISCH (Friedhauamt Sindelfingen) and G. SCHWENNER  
*Korrespondenz-Abwasser*, 1994, **41**, No. 9, 1564-1578 (in German, English summary)

A detailed study of the nitrification and denitrification performance of the trickling filter system of the Sundelfingen sewage treatment plant was performed, both in its original state and also with the interpolation of a separate denitrification stage, either before or after the trickling filters, indicated that around 50 per cent of the total nitrogen was already eliminated. This performance could be enhanced by the inclusion of a denitrification step prior to the filters, immediately after the primary settling stage. However, a similar improvement could be obtained more conveniently from a post-denitrification treatment, provided that an external carbon source was introduced as a substrate for the denitrifying organisms. Experiments using acetic acid as the carbon source gave encouraging results, the acetic acid being dosed as a 60 per cent solution in water at a rate of 80 litres per d. The sludge generated in the denitrification stage, and the supplementary final clarifier exhibited good settling properties and a highly efficient ratio for nitrogen removal to acetic acid introduced was obtained. (English translation 205 pounds sterling, valid for 1995). **Germany**

95-0377

#### Ecological studies of aerobic submerged biofilter on the basis of respiratory quinone profiles.

K. FUJII (Yokohama National University), H. Y. HU, H. TANAKA and K. URANO

*Water Science & Technology*, 1994, **29**, No. 7, 373-376

A method using respiratory quinone profiles was developed to identify different bacterial populations in the aerobic submerged biofilter process and changes in response to alterations in temperature and waste loadings. A packed silica column was used to purify and separate the quinones in the crude extract of microbial cells. Respiratory quinone profiles were then determined to characterize the bacterial populations present. The effects of a change in temperature and a shock loading of dimethylformamide were monitored in terms of quinone profiles and organic removals. The change of microbial phase in the course of acclimation was reflected in the quinone profile. **Japan**

95-0378

#### Reactor performance and microbial population characteristics in a channel with suspended and attached biomass.

Y. S. CHAO (International Institute for Infrastructural, Hydraulic and Environmental Engineering, Delft), S. J. ALBERTS and M. KAIJWSAENGTHAM

*Water Science & Technology*, 1994, **29**, No. 7, 61-62

Aerobic heterotrophic biodegradation in drainage systems with suspended and attached biomass was investigated in a thoroughly mixed recirculating indoor channel. Particular attention was given to microbial activity in the liquid and biofilm, the intrinsic kinetics of this activity and the overall process kinetics. The specific activities of both suspended and attached biomass were measured using a biological oxygen monitor. The specific activity of the suspended biomass was much greater than that of the attached biomass. The channel processes were dominated by the biofilm function. The biofilm oxygen uptake and substrate decomposition rate were velocity dependent. **Netherlands**

95-0379

#### Removal of formate from wastewater by anaerobic process.

H. K. CHUI (Environmental Protection Department), H. H. P. FANG and Y. Y. LI

*Journal of Environmental Engineering*, 1994, **120**, No. 5, 1308-1320

The effectiveness of the upflow anaerobic sludge blanket (UASB) process in removing formate from wastewater was assessed. Formate was removed in a laboratory UASB reactor by maintaining the recycle ratio at 3.0 and lowering the pH of the influent to 3.8. COD removal efficiencies of 97-98 per cent were achieved at loading rates of 10-20 g COD per litre d. When the loading was increased to 7.5 g COD per litre d the reactor failed abruptly due to the sudden decrease in pH. Around 94 per cent of the COD of the formate was converted to methane, with a sludge yield of 0.05 g volatile suspended solids per g of COD. The sludge granules settled satisfactorily. There are 34 references. **Hong Kong**

95-0380

**Submerged biological contactors - state-of-the-art secondary treatment.**

R. GOULD

*Water & Waste Treatment* 1994, 37, No 9, 48-49

Historical problems associated with submerged biological contactors (SBC) are identified. Improvements in SBC are considered and their use at Partington wastewater treatment works is briefly described. U.K.

95-0381

**Enhancing the performance of municipal sewage plants by the use of carrier materials in the aerobic biological treatment process.**

J. DANZIG and R. KUMMEI

*Abwassertechnik* 1994, 45, No 4, 58 and 61-64 (in German)

The opportunity of enhancing the treatment capacity of conventional activated sludge systems by the introduction of carrier materials or other types of fixed film supporting agents is reviewed. The advantages associated with a fixed film biocenosis include a reduction in space requirement (or an increase in the volumetric loading rate), an elevated sludge age, an increase in the sludge volume index, a reduction in the sensitivity to toxic impurities and load variations and an improved low temperature performance. As a result of the greatly increased surface area presented by the carrier material, very much higher biomass concentrations can be realized, and a lower level of sludge production is also obtained as a result of the increased grazing pressures from protozoans and other organisms present in the mixed biocenosis. The factors governing the growth and activity of the biofilm are discussed and the relative merits of a wide variety of different carrier materials considered, such as the basaltic rock or lava used in trickling filters, sand, expanded clay, activated carbon, powdered anthracite and brown coal and foamed plastic materials. Several proprietary systems using such supports are listed and the design of reactors incorporating various rigid supports or suspended carrier materials is also discussed to achieve maximal solids/liquid contact and hence the most efficient design of reaction vessel. There are 31 references. (English translation 240 pounds sterling, valid for 1995). **International**

95-0382\*

**Simulation of wastewater treatment plants by the activated sludge process.**

M. N. PONS (Laboratoire des Sciences du Genie Chimique, Nancy), N. ROCHÉ, O. POTIER, R. BENDOUNAN, I. PEREIRA, C. PROSE and E. P. CORRIOL

*HYDROTROP 94 Colloque: Microbiologie Eau, Marseille*, Vol. 2, 1994, 29-33 (in French, English summary)

A computer program was devised for the dynamic simulation of the performance of the activated sludge process, comprising a series of sub-models representing the primary settling stage, the aeration tank (of the longitudinal flow pattern) and the final settling tank. The aeration tank, employing submerged diffusers, was represented by a succession of well mixed and poorly mixed zones connected in series and the settling tanks by a series of annular layers. A model of the biological process for decomposition of organic matter and the effects of interferences from a variety of factors formed an integral part of the programme. The program was capable of simulating the effect of several variations in the sewage composition and flow rate for the plant of 100 000 PE rated capacity, together with the effect of changes in the operating conditions on the treatment performance resulting from changes in the control strategy. Thus the effects of

sludge recycling, sludge wastage and changes in the aeration intensity could be demonstrated. The program forms a valuable tool for the training of plant operators. **France**

95-0383

**Effects due to the dynamic behaviour of activated sludge systems in response to combined sewage flows.**

J. J. LONDONG (Wuppertalverband, Wuppertal)

*Korrespondenz Abwasser* 1994, 41, No 9, 1526 and 1535-1538 (in German, English summary)

For activated sludge plants receiving a high proportion of combined sewage, an increase in flowrate during periods of wet weather, due to the inflow of stormwater, can have a detrimental effect on treatment performance, which is particularly reflected in peak levels of ammonium nitrogen in secondary effluent. This effect, which frequently occurs when the input to the plant exceeds twice the dry weather flow, has been observed in large scale trials and is attributable to an inadequate nitrification performance, associated with a reduced retention time and possible wash out of nitrifying bacteria. The effect was simulated with the aid of the IAWQ dynamic model of the activated sludge system, from which operational rules and guidelines were derived for counteracting it, particularly with the aid of a buffer storage tank connected between the primary settler and the aeration tank. (English translation 180 pounds sterling, valid for 1995). **Germany**

95-0384

**Evaluation of biological parameters for the assessment of the treatment efficiency of activated sludge biocenoses.**

H. H. MMER (Bayerische Landesanstalt für Wasserversorgung, München)

*Korrespondenz Abwasser* 1994, 41, No 9, 1580-1584 (in German, English summary)

Various qualitative indicators of the activity and treatment performance of the biomass from several activated sludge plants were determined in an attempt to devise an objective method of assessing the treatment potential of the biocenosis. Methods are described for the determination of total colony count, population densities for various types of micro-organism, and levels of enzyme activity, as a method of characterizing the biomass samples derived from activated sludge plants treating either municipal sewage, paper and pulp mill effluents, chemical and petrochemical plant effluents and animal by-product effluents. Using the various indicators, a distinct similarity was observed for the biomass in the first and second stages of a municipal sewage plant, while much lower readings for all the biochemical parameters were obtained for the biomass from the other installations. Various suggestions for improving the ease of evaluation and differentiation between plants of different types are proposed as a basis for further refinement of the method. (English translation 205 pounds sterling, valid for 1995). **Germany**

95-0385

**Measurement, instrumentation and control strategies.**

K. SVARDAI (Technische Universität Wien)

*Korrespondenz Abwasser* 1994, 41, No 9, 1586-1596 (in German, English summary)

The increasing complexity of sewage treatment facilities and the need for continuous monitoring of plant variables to ensure compliance with the minimal quality standards requires an increasing amount of instrumentation and control equipment. The various biological reactions occurring in the course of sewage treatment in an activated sludge plant are discussed, together with the analytical

parameters or other indicators with reference to which their progress can be monitored and controlled. Thus the oxidation of organic matter, nitrification, denitrification, simultaneous aerobic sludge stabilization and phosphorus removal are considered, followed by descriptions of possible control strategies as a method of ensuring that the required level of treatment is maintained. Several alternative control parameters are discussed, including the ammonia content, oxygen consumption, nitrate content, redox potential and nitrogen loading, while the options for control of recirculation rate (as a function of nitrate content), biological phosphorus removal and sludge wastage are also considered. (English translation 360 pounds sterling valid for 1995) **Germany**

95-0386

**Operating experience with a physico-chemical treatment process for reducing the nitrogen load on the sewage plant due to sludge liquor recycling.**

T. THORNDAL (Bregnerødvej, Birkerød, Denmark).

*Correspondence: Abwasser*, 1994, **41**, No. 9, 1598-1602 and 1604. (German, English summary)

In the next 10-20 years are expected to see more and more sewage treatment plants equipped with mechanical dewatering facilities for sludge, with many smaller plants adopting centrifugal dewatering methods. The resulting concentrate or sludge liquor presents a serious problem, the most commonly used method being to return it to the sewage works intake. Owing to its high content of organic matter and nitrogen, the increased loading may cause the plant performance to be noticeably impaired. To prevent this and to develop a more acceptable, self-contained process for treatment of the liquors, a physico-chemical process has been tested on a large scale at several Danish and Swedish sewage treatment plants. The process involves a combination of pH adjustment and ammonia stripping, with the ammonia being absorbed into a chlorine solution, forming a weak acid and processed for sale. As a result the loading on the plant treatment process has been considerably reduced, with the ability to maintain a more consistent dissolved oxygen concentration in the aeration tank, and also a reduction in power consumption of the aeration equipment. Descriptions of typical installations are given together with an assessment of their economic benefits, and a bibliography is given. (English translation 380 pounds sterling valid for 1995) **Europe**

95-0387

**Incidence of *Aeromonas* species in influent and effluent of urban wastewater purification plants.**

M. L. STECCHINI (Udine University) and C. DOMENIS.

*Letters in Applied Microbiology*, 1994, **19**, No. 4, 237-239.

Sampling of the influent and effluent of 10 Italian activated sludge sewage treatment works was conducted between May-August 1993 to discover to what extent *Aeromonas* species present in the former were eliminated. Faecal coliforms were also counted, with a view to determining whether any species of *Aeromonas* was found preponderantly in conjunction with them. For selective culture of the *Aeromonas*, 2 types of medium (mA and starch ampicillin mA) were tried; the latter proved better. 32 per cent confirmed as against 26 per cent. Further species identification was conducted to learn whether treatment reduced some species more than others. Overall, treatment reduced the group by 96 per cent, but *Aeromonas caviae* (which was the dominant species in the sewage, and in waters with high levels of faecal pollution) was reduced rather more. Most of the species isolated at the works were not virulent strains. **Italy**

95-0388

**Response of sewage treatment plants to peak wet weather flows.**

J. GAUVENT (SIAM-AGHTM) and J. DE VILLARD.

*Techniques Sciences Methodes*, 1994, **89**, No. 7/8, 437-421 (in French, English summary).

A study group was established by the AGHTM to consider the effects of large stormwater inflows on the performance of activated sludge plants of conventional design and to evaluate the impact on treatment performance of a treatment plant having a design throughput of 825 m<sup>3</sup> per h of wet weather flows amounting to 30000 m<sup>3</sup> per h or 60000 m<sup>3</sup> per h for a period of 2 or 15 h. The effects of buffer storage capacity of 80000 m<sup>3</sup>, retention volume of the treated effluent, quality were also evaluated. The simulation studies indicated that a design capable of accommodating a flowrate equal to 6 times the DWI, together with buffer storage would be able to treat the combined sewage flow for all storm events with a frequency of 4 times per year, the entire volume of stormwater being treated within 24 h. This standard would require certain parts of the treatment system to be enlarged by as much as five-fold relative to present practice. The importance of allowing sufficient reserve capacity for treatment of stormwater is discussed, with reference to the results of a recent competition for the design of a treatment plant for Colombes, with a DWI of 240000 m<sup>3</sup> per d. The winning scheme was based on the use of a fixed film reactor, with capacity sufficient to handle up to 4 times the DWI for a period of 8 h. (English translation 350 pounds sterling valid for 1995) **France**

95-0389

**Sludge retention times distribution in clarifier: a key point for population dynamic and nutrients removal control.**

J. M. ALEJO (Commissariat des Eaux, Druize, Le Pecq, C.

LAYOUX, Y. TESTY and P. BRISSET.

*Water Science & Technology*, 1994, **29**, No. 1, 5-16.

Full scale experiments were conducted with 2 types of clarifier: a circular scraper type and a radial suction tubes clarifier, to determine the sludge retention time distribution. Conventional chemical tracers were not suitable for this purpose, due to difficulties in obtaining representative sludge sample. Radioactive gold, which had a strong affinity for flocs without affecting their behaviour, was used. The circular scraper clarifier was affected by a short circuit involving up to 40 per cent of the sludge. Up to 5 per cent of the sludge remained in the system for more than 5 h. The suction clarifier showed an excellent sludge distribution with time, with a thin sludge bed, but this was rapidly affected by an increase in the sludge bed depth. **France**

95-0390

**Settling characteristics of activated sludge from Danish treatment plants with biological nutrient removal.**

G. H. KRISTENSEN (Water Quality Institute, Hørsholm), P. J.

JORGENSEN and P. H. NIELSEN.

*Water Science & Technology*, 1994, **29**, No. 1, 157-165.

Settling characteristics and dominating filamentous microorganisms of activated sludge from nutrient removal systems in Denmark were investigated between 1989 and 1991. Seasonal variation in sludge settling characteristics were also studied at 3 treatment works. The filament index, sludge volume index, and types of microorganisms responsible were determined. Sludge settling characteristics showed a distinct variation with season, improving during summer and deteriorating during winter. For activated sludge with a high content of filamentous microorganisms, the best parameter for

following variations in settling properties was the filament number  
Denmark

95-0391

## The implementation of bulking control in the design of activated sludge systems.

J. WANNER (Prague Institute of Chemical Technology)  
*Water Science & Technology* 1994, 29, No 7, 193-202

Factors affecting the growth of the most common filamentous micro-organisms in activated sludge systems were examined. Aspects to be considered in developing a design included the readily and slowly degradable components in the wastewater, the biomass retention time, the substrate concentration in the reactor and the operational parameters (dissolved oxygen and nutrients concentrations, pH and temperature). Process configurations supporting the growth of floc-formers are considered. Process parameters used in successful attempts to control bulking are summarized. The feasibility of developing mathematical models of the process is evaluated. There are 40 references. Czech Republic

95-0392

## Systematic activated sludge bulking and control.

R. J. FOOT (Wessex Water Services, Bristol), M. S. ROBINSON and C. E. FORSTER  
*Water Science & Technology* 1994, 29, No 7, 213-220

A method for the quantitative definition and systematic control of bulking and foaming activated sludges was proposed. Although a much better understanding of the conditions which promoted bulking and foam formation was available than previously, the order in which corrective measures should be implemented had not been defined. A logical route by which decisions on control methods could be made is suggested, with measures ranked in order of the effort and cost involved. Process options concerned merely valve and aerator adjustments, while operational modifications required minor alterations to the treatment works. The most expensive measures involved the design and construction of additional reactors. U.K.

95-0393

## Contact zone: French practice with low F/M bulking control.

R. PLIOU (Degrémont Recherche, Le Pecq), and J. P. CANIER  
*Water Science & Technology* 1994, 29, No 7, 221-228

The effectiveness of the contact zone technique in the control of sludge bulking in the activated sludge process was investigated. Twelve wastewater treatment works in France employing this technique were studied. In 91 per cent of cases, a reduction in the sludge volume index was achieved, while the situation with respect to foaming was improved in 75 per cent of cases. Attention was focused on units with a low feed micro-organisms ratio in which organisms such as *Microthrix parvella* or type 0041 were identified. The use of contact zones did not impose any limitations on system operation. Effective use of the contact zone approach is discussed. France

95-0394

## Biological foams: the cause-effect relationship, test results and combat strategy.

P. DUCHENE (Cemagref, Paris)  
*Water Science & Technology* 1994, 29, No 7, 239-247

The occurrence of biological foams in French wastewater treatment works was surveyed. The principal public and private organizations operating treatment works in France took part in the survey. Of the 20 per cent of works reporting foaming problems, *Microthrix* was implicated in 60 per cent, and Nocardioforms in only 14 per cent. A

statistical analysis showed few factors firmly connected with foaming, but experiments at more than 40 activated sludge treatment systems helped to identify cause-effect relationships and methods for the reduction of foaming. These varied with the type of dominant filamentous micro-organisms. Control strategies were proposed. France

95-0395

## Investigation of a bacteria-enzyme additive to prevent foaming in activated sludge plants.

A. FRANZ (Vienna Technical University) and N. MATSCHI  
*Water Science & Technology* 1994, 29, No 7, 281-284

Foaming in activated sludge systems, frequently associated with the presence of *Nocardia* species and *Microthrix parvella*, was particularly prevalent when fats and oils were a major fraction of the organic content of the waste water. The usefulness of bacterial and enzyme additives, reported to prevent the growth of nocardioform actinomycetes when added to the mixed liquor, was investigated. Batch experiments were conducted at laboratory scale with mixed liquors from various treatment units. Full scale trials were also conducted. Using the additives failed to produce significant improvements in systems affected by foaming and scum formation. Austria

95-0396

## Scumming due to Actinomycetes: an uncalibrated simulation model.

J. KAPPELER (Boehringer AG, Oberwil) and W. GUER  
*Water Science & Technology* 1994, 29, No 7, 285-288

A mathematical model was developed to simulate problems arising with the proliferation of *Actinomycetes* and the resulting scum formation. The model incorporated aerobic and anoxic growth of floc-forming micro-organisms on all biodegradable substrate fractions, aerobic growth of *Actinomycetes* on all biodegradable substrate fractions, nitrification, lysis of *Actinomycetes*, heterotrophic floc-forming micro-organisms and nitrifiers, and hydrolysis of all particulate biodegradable wastewater fractions. The model was capable of simulating the principal operational problems occurring in practice. The presence of surfactants could produce a rapid increase in the *Actinomycetes* population of activated sludge. Switzerland

95-0397

## Improvement and control of the microbial activity of a mixed population for degradation of xenobiotic compounds.

G. BUIERON (Institut National des Sciences Appliquées, Toulouse), B. CAPDEVILLE and P. HORNY  
*Water Science & Technology* 1994, 29, No 7, 317-326

The microbial activity required for the degradation of xenobiotics was monitored and optimized using a computer aided sequencing batch reactor. The control parameter used was the carbon dioxide evolution rate. Activated sludge acclimated to 4-chlorophenol was used as inoculum for the reactor. An optimal specific substrate degradation rate of 116 mg of 4-chlorophenol per g of mixed liquor suspended solids/h was obtained. The corresponding value with a conventional 24-h cycle policy was only 20 mg. The ability of acclimated micro-organisms to degrade 4-chlorophenol declined as a result of starvation periods. Inductive enzyme activity decreased by 80 per cent after 6 h of starvation. France

95-0398

**Inactivation of faecal bacteria in sewage sludge by alkaline treatment.**

L. ALLIEVI (Università degli Studi di Milano), A. COLOMBI, E. CALCATERRA, and A. FERRARI

*Bioresour. Technology*, 1994, 49, No 1, 25-30

Ammonium or potassium hydroxides were used to inactivate municipal wastewater sludges intended for application to agricultural land. The sludges were treated until the pH was 10.5 and were then stored at 20-25°C for 60 d, although the effects were studied after storage for about 10 d at various temperatures. At the beginning and end of storage, fungi, aerobic and anaerobic bacteria, total and faecal coliforms, and faecal streptococci were counted as being representative of the total microflora and faecal indicators. In general, ammonium hydroxide was more effective in deactivating faecal bacteria than potassium hydroxide, and its efficacy was to be independent of the storage temperature, at least when the sludge was stored above 10°C. **Italy**

95-0399

**Parameters for controlling the operation of a UV disinfection apparatus for sewage effluent.**

K. U. RUDOLPH (Universität Witten/Herdecke), J. BOTTCHER, and E. NEFF

*GW-Wasser-Abwasser*, 1994, 135, No 9, 529-533 (in German, English summary)

The operation of a portable UV irradiation unit as a method of disinfection of treated sewage effluents at several sewage treatment plants is discussed. The efficiency of the UV disinfection process was dependent on certain parameters: in addition to the flow rate, namely, the dose (a product of the intensity and duration), the transmission of the aqueous medium and the turbidity or presence of absorbable solids in the flow. From on-line measurements of these parameters, accompanied by appropriate microbiological analyses, namely, coliform counts in the irradiated effluent were correlated with higher values of turbidity or lower values of transmittance. The application of sensors for the on-line determination of changes in transmittance and turbidity could accordingly be used to control the operation of the UV disinfection unit, so that the operating costs and performance of full-scale irradiation units could be optimized. (English translation, £30 pounds sterling, valid for 1995). **Germany**

95-0400\*

**Purification of reject water at sewage works**

C. THORNDAL (Watergroup A/S, Denmark)

*HYDROTOP 94, Colloquium: Mursverket, Eau, Marseille, France*, Volume 2, 1994, 401-426 (in English)

Progress in the elimination of nutrients from treated sewage effluents, in particular those discharged from Scandinavian countries into Baltic waters is reviewed, with special reference to various methods for treatment of sludge liquors such as denitrification and phosphorus elimination, precipitation of ammonium ions as magnesium ammonium phosphate (MAP method) and the physico-chemical process developed by the firm Watergroup A/S, in which the pH is raised by the addition of lime, accompanied by phosphorus coagulation and sedimentation, followed by gaseous stripping of ammonia which is subsequently converted into ammonium sulphate by absorption with diluted sulphuric acid in a scrubbing tower. While the first 2 methods have only been tested on a pilot-plant scale, several full-scale plants based on the physico-chemical method have been installed in Denmark and Sweden, including a recently constructed plant for Eskov, Sweden, which enables the total nitrogen content of the treated

liquor to be reduced to only 16 mg per litre (65 per cent reduction), while producing a high quality ammonium sulphate marketed as a fertilizer. Further plant optimization is expected to reduce the nitrogen concentration even further, to 12 mg per litre. The operation of all these plants removes a considerable nutrient load from the sewage plant intake formerly associated with the recycling of sludge liquor. **Scandinavia**

95-0401

**Rate-capacity characterization of wastewater for nutrient removal processes.**

M. HENZI (Denmark Technical University, Lyngby), G. H. KRISTENSEN, and R. STRUBB

*Water Science & Technology*, 1994, 29, No 7, 101-107

The influence of wastewater characteristics on treatment processes is considered. The carbon sources present affected the oxygen uptake rate, the denitrification rate and the biological phosphorus uptake rate. Respiration rate determinations for the biodegradable fractions of wastewater were coupled with removal capacities to produce rate capacity diagrams. These were intended to provide a fuller picture of the wastewater and its influence on the biological processes. Rate capacity diagrams for raw, primary settled and primary precipitated wastewater were prepared. In practice, the rate capacity curves were coupled to the design and operation of the treatment system. **Denmark**

95-0402

**The effect of incomplete denitrification on anoxic-aerobic (flow F/M) filament bulking in nutrient removal activated sludge systems**

E. A. MUSVOTO (Cape Town University), E. G. CASEY, G. A. EKAMA, M. C. WENTZEL, and G. V. R. MARAIS

*Water Science & Technology*, 1994, 29, No 7, 295-299

The hypothesis that the alternation of anoxic and aerobic conditions in nutrient removal activated sludge systems was the principal factor influencing the onset of filamentous bulking in low feed microorganisms conditions was investigated experimentally. The results provided strong supporting evidence for the hypothesis. High residual nitrite concentrations in the inflow to the aerobic reactor had a stronger and more rapid effect on the diluted sludge volume index than nitrate. This suggested a dominant role for nitrite in the production of bulking, due to the competitive advantage characterizing filamentous organisms as a mixed flow formers in high nitrite conditions. **South Africa**

95-0403

**Initial experience with a fuzzy logic control system for optimizing nitrogen removal at a municipal sewage treatment plant**

J. HANSEN (Universität Kaiserslautern), M. KRAUSS, and B. BUCHHOLZ

*Abwassertechnik*, 1994, 45, No 4, 35-38 (in German)

The application of a fuzzy logic control system as a method of optimizing the nitrification performance and energy consumption of a small sewage treatment plant was tested on a carousel type plant at Elsbach. The plant had a rated capacity of 12 000 PE, and the activated sludge compartment had a volumetric capacity of 3000 m<sup>3</sup>. A standard 2-point programmable control system was installed, in which the limiting values of ammonium nitrogen concentration could be set at 0.3 and 0.8 mg per litre, and this was subjected to a trial period of operation during which some weaknesses were apparent. In an effort to improve the performance of the control system, a fuzzy logic system was introduced with a total of 4 fuzzy sets of

## SEWAGE

operating parameters which included the option of preferred aeration during the night time off peak period for electricity charges. The behaviour of this system was then compared with that of the conventional two point control system. The results showed that under normal operating conditions both systems gave broadly similar results, but that under extreme conditions (such as the peak ammonium loadings resulting from cleaning out the stormwater retention tank) the fuzzy logic system prevented swings in the response of the controller and permitted a more stable level of operation to be maintained. (English translation 180 pounds sterling valid for 1995) **Germany**

### 95-0404

#### **Factors affecting nitrite buildup in submerged filter system**

O. T. HAO (Maryland University College Park) and J. M. CHEN *Journal of Environmental Engineering* 1994, 120, No 5, 1298-1307

Ways of limiting the accumulation of nitrite in submerged filter wastewater treatment systems are considered. High effluent nitrite levels were undesirable because of toxic effects on fish. They also significantly increased amounts of chlorine required for disinfection. The role of hydraulic and ammonium loading rates, pH and alkalinity in controlling nitrite accumulation were investigated in a fixed film system. High nitrite levels were observed at higher hydraulic and ammonium loading rates, at a pH of 8.8 and at a low alkalinity/ammonium ratio. The addition of hydroxylamine also significantly enhanced nitrate accumulation and inhibited *Nitrobacter* irreversibly. **U.S.A.**

### 95-0405

#### **Population dynamics and nitrite build-up in activated sludge and biofilm processes for nitrogen removal**

J. L. ROUS (Institut National des Sciences Appliquées, Toulouse), M. MAUREL, H. RAHMANI, K. M. NGUYEN, B. CAPDEVILLE, J. C. CORNIER and A. DEGLIN *Water Science & Technology* 1994, 29, No 7, 43-51 (in French, English summary)

The relationship between the growth dynamics of autotrophic populations responsible for nitrification and uncontrolled accumulation of nitrite ions was investigated. Nitrite accumulation resulted in a disequilibrium in number or viability between the genera *Nitrosomonas* and *Nitrobacter*. The disequilibrium could result from inhibition of the activity of *Nitrobacter* due to the presence of free ammonium. The inhibition threshold and the level of nitrite accumulation depended on the history of the sludge utilized as inoculum and on the hydraulic regime of the reactor. These results improved understanding of the operation of nitrification reactors and the nitrite accumulation problem. (English translation 200 pounds sterling valid for 1995) **France**

### 95-0406

#### **Fate of readily biodegradable substrate under anoxic conditions**

A. D. ANDRIADAKIS (Athens National Technical University) and G. J. CHATHIKONSTANTINOU *Water Science & Technology* 1994, 29, No 7, 53-56

The fate of soluble readily biodegradable substrate in transient anoxic conditions was investigated to characterise substrate uptake and determine the factors affecting this uptake or accumulation. Nitrate reduction processes were also studied. Anoxic batch experiments were conducted with variable initial soluble substrate concentrations. Changes in COD uptake rate, nitrate uptake rate and mixed

liquor suspended solids were monitored. Aerobic experiments were also carried out for comparison. Observed similarities in the transient responses of COD and nitrate uptake rates indicated that the 2 mechanisms were connected. In anoxic conditions, the carbon uptake mechanism requiring energy caused a corresponding reduction in nitrates. **Greece**

### 95-0407

#### **Aerated anoxic biological NdeN process**

O. E. ALBERTSON (Enviro Enterprises, Inc., Salt Lake City, Utah) and H. D. STENSEL *Water Science & Technology* 1994, 29, No 7, 167-176

A biological nitrification/denitrification process involving nitrate recycle to aerated selector zones and the provision of anoxic zones with a dense array of fine bubble diffusers was developed for the 91st Avenue wastewater treatment works in Phoenix, Ariz. The prototype process was able to maintain a 1-3 l/m<sup>3</sup> per second capacity with an aerated anoxic zone receiving 20-25 per cent of the total airflow. Net sludge yields were up to 50 per cent higher than expected due to primary clarifier solids losses at higher flows. With a solids retention time of 5.0-5.5 d, the effluent quality averaged 8.3 mg total nitrogen per litre, 1.75 mg ammonium nitrogen, and 5.7 mg nitrate nitrogen per litre. **U.S.A.**

### 95-0408

#### **Nitrification kinetics in activated sludge with both suspended and attached biomasses**

P. CHU DOBA (Département Recherche Centre Le Picquet) and M. PANNIER *Water Science & Technology* 1994, 29, No 7, 181-184

A combined activated sludge treatment system in which a plastic support for biomass growth was introduced into the aeration tank was studied with respect to nitrification kinetics. The results of batch kinetic tests were compared with kinetics calculated from a continuously run pilot unit. The nitrification kinetics of suspended and attached biomasses were similar. The proportion of autotrophs was the same in both biomasses. The kinetic constants measured for the suspended biomass of the system were higher than published values. This was possibly due to over-aeration of the experimental system together with a high level of mixing. **France**

### 95-0409

#### **Influence of predators on nitrification in aerobic biofilm processes**

N. M. LEE (Lund University) and T. WELANDER *Water Science & Technology* 1994, 29, No 7, 355-363

Two aerobic continuous flow suspended carrier biofilm reactors operated in parallel were used in a laboratory study of the influence of predators on nitrification in aerobic biofilm processes. With nitrification established and stable operating conditions at a hydraulic retention time of 3 h obtained, substances inhibitory to eucaryotic organisms were added to one reactor to inhibit predators. A rapid decrease in the quantity of biofilm consuming predators, mostly rotifers and nematodes, and a simultaneous increase in nitrification were obtained. The level of nitrification stabilized at twice that in the control reactor to which no inhibitors were added. There are 30 references. **Sweden**

95-0410

**Stoichiometric model of the aerobic metabolism of the biological phosphorus removal process.**

van der SMOLDERS (Delft University of Technology), J. van der MEIJ, M. C. M. van LOOSDRECHT, and J. J. HEIJNEN. *Bio-technology and Bioengineering*, 1994, 44, No. 7, 837-848.

The kinetics of the biological phosphorus removal process were studied and a structured metabolic model of the aerobic phase was developed in which the use of poly-beta-hydroxybutyrate (PHB) for polyphosphate synthesis, growth, and glycogen synthesis was quantified. The energy consumption of biomass synthesis from PHB, phosphate transport and polyphosphate synthesis and glycogen production was determined. The maximal yield for biomass formation, polyphosphate synthesis, and glycogen formation on oxygen were expressed as a function of the phosphorus/oxygen ratio; the coefficient for the transport of phosphate and polymerization constant, and maintenance energy. The aerobic metabolism of phosphorus removal was studied in a sequencing batch reactor. The uptake of phosphate and storage as polyphosphate had a direct effect on the oxygen consumption in the aerobic phase. The phosphate recovery cycles in biological phosphorus removing organisms had a type energetic effect on the metabolism of the organisms: 15 percent of added acetate and about 30 percent of oxygen consumption were required for the uptake and storage of phosphate.

Netherlands

95-0411

**Biological phosphate removal - practical experience at three large scale treatment plants**

WOLFF, Universität GIESSEN, U. TIEGMANN, and K. MEHMEN. *Water Science & Technology*, 1994, 33, No. 9, 509-510, and 513-514 (in German). English summary.

A short overview is given of operating trials at 3 full scale sewage treatment plants (Dreieich, Darmstadt, Eberstadt and Alsfeld) which have been modified to permit an appreciable degree of phosphorus removal to take place. The 3 treatment plants differed in their general layout and treatment capacity, the latter ranging from 75,000 PE at Dreieich to 42,600 PE at Alsfeld, although all 3 plants were operating considerably below their rated capacity. The best results in terms of phosphorus removal were achieved at the Darmstadt-Eberstadt treatment plant, which was designed on the basis of the Phostrip 2 process and incorporated chemical coagulation as a method of stripping the excess phosphate from the recirculating sludge. Nevertheless considerable modifications were necessary to achieve the required phosphorus removal performance to be achieved. The original time coagulation reactor became so hopelessly clogged with lime deposits that a new, larger reactor connected directly to the clear water zone of the stripper tank was installed. The other 2 plants also required substantial changes to the anaerobic zone of the recirculation system, but it became apparent that these plants based on the Phoredox process would not consistently achieve total phosphorus concentrations below about 2 mg per litre in the final effluent without the use of auxiliary irrigation treatment. (English translation 290 pounds sterling, valid for 1995). Germany

95-0412

**Survey of the present state of practice for biological phosphorus removal in the German-speaking area**

H. SCHIEFER (Universität Hannover).

*Correspondence* *Water Science & Technology*, 1994, 41, No. 9, 1546-1550, and 1553-1556 (in German, English summary).

A comprehensive survey of existing and proposed systems for phosphorus removal by biological methods at sewage treatment plants in Germany was performed. Following a description of the principles of the method and of the various plant configurations employed, the present practice concerning the design of such systems is reviewed, the options available for upgrading existing treatment plants discussed, and the performance of the relevant plants also analysed in statistical terms, showing the numerical distribution relative to the extent of phosphorus removal obtained. At present more than 125 treatment plants are operating some form of biological phosphorus removal, that most frequently employed being based on the Phoredox method. In addition a further 240 plants are at the planning stage or under construction. (English translation 260 pounds sterling, valid for 1995). Germany

95-0413

**Phosphate removal by floating aquatic plants**

C. MICHAUD, Le Groupe SHERA Inc., Rock Forest, P.Q., Canada; M. MARIN, N. RONDEAU, and R. THERIAULT.

*Science et Techniques de l'Eau*, 1994, 27, No. 6, 33-40 (in French). English summary.

Where phosphate removal is called for in sewage treatment systems using facultative ponds, dosage with coagulants such as ferric or aluminum salt is frequently employed. This method gives rise to accumulations of sludge containing iron or aluminum complexes which may be harmful to the environment. An alternative method, the use of floating plants of the water hyacinth (*Uchhornia crassipes*) and duckweed (*Lemna minor*, *Lathyrus*, and associated genera) is reviewed. Published data concerning their metabolic growth and phosphorus uptake is reviewed, indicating their potential for phosphorus removal providing the biomass is regularly harvested. The phosphorus removal rate varies widely depending on productivity, plant density, available nutrients, ambient temperature and duration of sunlight and harvesting frequency. The limited extent to which these factors can be controlled suggests that the use of these plants may provide a method of phosphorus removal given suitable ambient conditions, in particular those prevailing in temperate climates during the summer season. Estimates of productivity and phosphorus uptake by the plant biomass are included. There are 58 references. (English translation 255 pounds sterling, valid for 1995).

International

95-0414

**Metabolisms of different bacterial populations in enhanced biological phosphate removal process**

T. MINO (Tokyo University), H. SATOH, and E. MATSUO.

*Water Science & Technology*, 1994, 29, No. 7, 61-70.

The anaerobic/aerobic biological phosphate removal process was studied with respect to the characteristics of 2 major bacterial population groups: the phosphate accumulating organisms and the so-called G-bacterium. The latter organism grew significantly when glucose was used as the carbon source for anaerobic/aerobic processes and induced the failure of enhanced biological phosphate removal. The regulation of the oxidation/reduction balance was essential to the process, enabling both types of micro-organisms to



survive in the anaerobic/aerobic process. Selective forces enabling the dominant growth of either type of organism are considered.  
**Japan**

**95-0415**

**pH: key factor in the biological phosphorus removal process.**

G. J. F. SMOLTERS (Delft University of Technology), M. C. M. van LOOSDRECHT and J. J. HEIJNEN

*Water Science & Technology*, 1994, **29**, No 7, 71-74

The effect of pH on biological phosphorus removal in the activated sludge process was investigated using a sequencing batch reactor. The reactor was operated with a cycle of 6 h, consisting of an anaerobic period (2.25 h), an aerobic period (2.25 h) and a settling period (1.5 h). Operating results showed that pH had a major influence on phosphorus release, which fluctuated between 0.25 and 0.75 mol phosphorus per mol carbon removed. Glycogen metabolism occurred during anaerobic conditions, even when no glucose was present in the medium. The pH effect was important for full scale processes, with possible implications for the efficiency and economics of the Phostrip process. **Netherlands**

**95-0416**

**Bacteria and protozoa population dynamics in biological phosphate removal systems.**

J. S. CÍECH (HYDROTECH s.r.o., Ceske Budejovice), P. HARTMAN and M. MACEK

*Water Science & Technology*, 1994, **29**, No 7, 109-117

A laboratory sequencing batch reactor simulating an anaerobic/oxic activated sludge system was used to study the population dynamics of polyphosphate accumulating bacteria. The competition between these bacteria and other bacteria which accumulated polysaccharide rather than polyphosphate, known as G-bacteria, for anaerobic/oxic utilization of acetate as the sole source of organic carbon was studied. G-bacteria were resistant to predation by protozoa and metazoa. This enabled them to out-compete polyphosphate accumulating bacteria. Several breakdowns of enhanced biological phosphorus removal were observed. There are 37 references. **Czech Republic**

**95-0417**

**Full scale investigations on enhanced biological phosphorus removal - P-release in the anaerobic reactor.**

D. WIEDI (Munich Technical University) and P. A. WILDERER

*Water Science & Technology*, 1994, **29**, No 7, 153-156

Laboratory tests in defined conditions with pure or enriched cultures successfully reproduced most of the fundamental processes responsible for enhanced biological phosphorus removal in full scale systems. The most important bacterial group responsible for biological phosphorus removal consisted of *Acinetobacter* species. Measurements with a full scale Phoredox system, however, showed surprisingly low phosphorus release in the anaerobic reactor, compared with laboratory results (4-10 per cent, compared with up to 20 per cent). This was attributed to a lower proportion of *Acinetobacter* species in the full scale system, due to prevailing process conditions. **Germany**

**95-0418**

**Studies of oxygen input rates as a function of biological variables and operating parameters.**

H. STREINMÜTZ

*Abwassertechnik*, 1994, **45**, No 4, 29-30 and 32-34 (in German)

For the design of aeration equipment for use in activated sludge systems a value of  $L$  must be adopted which reflects the difference

in the oxygen transfer rate achieved in the mixed liquor suspension and that in pure water. Since the value of this coefficient is dependent on a variety of factors, in a manner which had been poorly investigated, studies of the effects of the activity and composition of the biomass, together with other operating variables, were performed. The results showed that the relationships were less dependent on the intensity than on the nature of the metabolic processes. While there was some evidence of a trend towards lower  $L$  values as the MLSS content of the suspension increased, other operating variables were of no influence, given a continuous supply of substrate. Shock loadings differed in their effects according to the value of the sludge age. Despite appreciable variations in the level of extracellular polymers (ESP) observed in the course of batch fermentation tests, no effect attributable to the ESP concentration on the oxygen transfer rate was apparent. (English translation 210 pounds sterling valid for 1995). **Germany**

**95-0419\***

**Infiltration/percolation as a tertiary treatment.**

F. BRISAUD (Université Montpellier, France) and M. SAI GÖT

*HYDROTOP 94 Colloque Médiagérer l'Eau, Marseille, France*, Volume 2, 1994, 391-399 (in English)

Experiments were carried out using a specially designed sand filter for tertiary treatment of the effluent from the activated sludge sewage treatment plant at Vall d'Ibrega, Spain. The filter was circular in plan with a filter medium consisting of dune sand 1.5 m deep supported on a shallow layer of gravel. Secondary effluent was applied from a rotating spreader arm pivoted at the centre; the speed of travel of the arm being regulated according to the hydraulic loading rate required; during each rotation a volume of effluent equivalent to a depth of 4-7 cm was applied, the arm being driven by a motor and wheel supported on the outer perimeter of the filter. The changes in physico-chemical and biochemical parameters during passage through the filter, together with the reduction in total coliform and faecal coliform counts, were monitored during the period from October 1992 to July 1993. During the initial period up to the end of 1992 the hydraulic load was controlled at 0.35 m per d, but this was reduced to only 0.165 m per d for the remainder of the trial. Data showing substantial reductions in the counts of faecal indicator organisms are presented, together with evidence of the removal of organic matter and almost complete nitrification of the effluent. Complete elimination of microorganisms was not achieved, and a further disinfection stage would be necessary in order to comply with the bacteriological standards for effluent reuse. **Spain**

**95-0420**

**Bacteriological studies concerning the ecological and infective disease control of natural plant-based treatment systems.**

W. RÖRNERT (Umlandverband Frankfurt) and H. HAGENDORF

A. MORELL and K. SEIDEL

*Korrespondenz Abwasser*, 1994, **41**, No 9, 1540-1545 (in German, English summary)

A group of 5 plant-based sewage treatment systems of varying characteristics was selected for a detailed evaluation of their bacteriological elimination performance. The plants could be classified into planted soil filters, multi-stage filter beds and root zone (horizontal flow) systems. The plants which incorporated sandy soils achieved a greater degree of reduction in sewage-related organisms than those with silty or clay soils such as the root zone system. A reduction of 2 to 3 powers of ten in the concentration of the relevant organisms (*Escherichia coli*, total coliform, faecal streptococci) and

*Salmonellae*) could be achieved more reliably in permeable soils or sand beds than in those of low permeability. For the root zone systems examined, the poor hydraulic conductivity and lack of aeration were associated with a reduction of only 10-fold in the numbers of relevant organisms. However, where the effluent was collected in a polishing pond prior to discharge, the bacterial quality of the pond effluent was generally comparable to that from the sand filters and planted sandy soil beds. Appreciable reductions in the bacterial counts for effluent from the horizontal flow systems were observed only when ponding occurred at the surface and lateral flow occurred through the litter layer. (English translation 140 pounds sterling valid for 1995)

Germany

#### 95-0421

##### Design of systems for the treatment of municipal wastewaters from Quebec using artificial wetlands.

P. VILLETTEUF (Les Consultants RSA - Alma, P.Q.) and P. MALTAIS

*Water Sci. Techniques de l'Eau*, 1994, 27, No 3, 45-54 (in French, English summary)

The application of wetland plant treatment systems as a method of treating municipal sewage in the Canadian environment is discussed in view of published reports and previous experience with these systems in Canada, the first of which was installed in 1980 at St-Jovite. Over 13 systems of this kind are currently in use in Quebec province. Two alternative versions are distinguished, namely those involving horizontal sub-surface (HSS) flow, usually with cohesive sediments, for use when organic loading rates are relatively low, and those involving downward percolation, usually through coarse sand or gravel, which are more suited to moderately high organic loadings and may be installed as a preliminary stage in line with an HSS system, thus ensuring adequate removal of coarse particulate solids and clarification of the liquid. General descriptions are provided for the layout of the beds together with the inlet and outlet pipework, and for the selection of the number of stages and the size of the beds, dependent on the hydraulic loading rate and permeability of the bed material. (English translation 350 pounds sterling valid for 1995) Canada

#### 95-0422

##### Dimensional design of sewage sludge facilities with reference to various dewatering and disposal options.

A. BLEIB (Abwasser Verband Saar, Saarbrücken), H. D. JUNG and W. WAGNER

*Abwassertechnik*, 1994, 45, No 4, 15-16 and 25-27 (in German)

The selection of the most economic solution for the installation of sludge storage facilities at sewage treatment plants is examined in the view of experience. The necessary storage volume depends on a number of factors, including the solids content, the rate of sludge production, the ultimate disposal method, and the possibility of increasing available storage capacity at a nearby site. In certain cases, sludge dewatering equipment may substantially reduce the cost of storage, while the use of mobile dewatering plant also eliminates the high cost of fixed dewatering equipment, while offering economies in connection with the transport of dewatered rather than liquid sludge. Some of the empirical correlations and methods of costing reviewed by the AVS when comparing different methods on economic grounds are reviewed, based on a standard sludge production rate of 6 kg sludge solids per person/d. (English translation 210 pounds sterling valid for 1995) Germany

#### 95-0423

##### Fifteen years of successful sludge treatment and disposal

D. W. BLACK (Severn Trent Water Ltd)

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille France*, Volume 2, 1994, 375-381 (in English)

The nature of the sewage sludge collection, treatment and disposal activities carried out by the Severn Trent Water and sewerage undertaking is reviewed. During the last 20 years substantial improvements have been made to all aspects of the sludge handling operation. At the collection stage, a target of 6 per cent solids has been set for the sludge at the point of origin prior to transport to central treatment centres. The treatment now involves 2 stage mesophilic anaerobic digestion and compliance with minimal storage periods before application to land. Around 68 per cent of the total is applied directly by landspreading, the remaining 32 per cent being mechanically dewatered by centrifugal or filter press methods. Half of the resulting sludge cake is incinerated and the remainder is used either for land treatment or landfilling. Various techniques have also been devised for mitigating the adverse effects of sludge spreading, and low level applications or injection systems are employed to eliminate windborne drift. Presently the greatly reduced levels of metal contamination mean that the metal content of sludges is no longer the limiting factor for the rate of application, which is now controlled by the nutrient levels, especially nitrogen application rates. U.K.

#### 95-0424

##### The battle for reducing the volume of municipal sewage sludges: examples from three major European cities: Amsterdam - Nuremberg - Zurich

J. P. CHABRIER (Buss A.G., Basel, Switzerland)

*HYDROTOP 94 Colloque Mieux gérer l'Eau - Marseille France*, Volume 2, 1994, 436-449 (in French)

The inexorable rise in the quantities of sewage sludge generated by municipal treatment plants is discussed as a preliminary to a description of 3 major sludge drying installations in the cities of Amsterdam (under construction), Nuremberg (at the start up stage) and Zurich (in operation since 1989). All these plants are designed to raise the solids content to a level of 90 per cent by 2 stage indirect drying using the process developed by the Swiss firm of Buss A.G. Both stages utilize surface contact processes, the first being of the thin film scraped surface type (DAS dryer) and the second comprising a rotating paddle dryer (ROVACTOR) equipped with a series of hollow discs heated on the interior. Typical design and performance data are given in respect of each of these large scale plants, together with the various outlets for the dried sludge. Where phosphorus removal processes are an integral part of the sewage treatment plant, the dried sludge contains a sufficient level of phosphorus to render it suitable for use as a fertilizer. The product from the Zurich drying plant is imported into the U.K. for use as a raw material in the manufacture of artificial fertilizers. Europe

#### 95-0425

##### Comparison between dynamics and control performance of mesophilic and thermophilic anaerobic sludge digesters

I. M. ALATIQI (Kuwait University, Safat), A. A. DADKHAH, A. M. AKBAR and M. F. HAMOUDA

*Chemical Engineering Journal*, 1994, 55, No 3, B55-B66

A closed-loop control system was designed for the anaerobic process that may be used for the digestion of wastewaters which are high in suspended solids. The model for the control system is based on measuring the substrate concentration using the COD method, and

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considered 3 distinct variable types (controlled, manipulated and disturbance variables). Substrate concentration and influent temperature were the disturbance variables, sewage sludge influent rate and specific heat addition rate represented the manipulated variables and the effluent substrate concentration and the digestion temperature were the controlled variables. **Kuwait**

**95-0426**

### **The simplicity of sludge digestion.**

R. CHERRY (Environmental Construction Ltd.), *Water & Waste Treatment* 1994, **37**, No 9, 46.

Advantages of the anaerobic sludge digestion process are identified. The process is briefly described and possible future improvements considered. **U.K.**

**95-0427**

### **Municipal sludge properties and flocculation behaviour**

A. HEMME (FH Anhalt/Köthen, FB Verfahrenstechnik und Umwelttechnik, Köthen) and P. AY.

*Filtration & Separation* 1994, **31**, No 6, 647-651.

The problems associated with optimizing sludge conditioning with polymeric flocculation agents were examined with an arrangement consisting of a sedimentation unit, video camera and a computer. Photographic measurements enabled data to be obtained on the settling velocity, flocc density, shape factor and the Reynolds number. This data is valuable in that it reflects changes in the flocculated system due to energy input changes or by increased polymer dosing. In addition, changes in the thickening or dewatering properties of the flocs may be examined with this arrangement. **Germany**

**95-0428**

### **Implementation of peat-based treatment systems for on-site treatment of domestic sewage in Quebec: state of the art. Part one - Premier's experience**

P. TALBOT (Centre de recherche Premier et Premier Tech Inc., Rivière du Loup).

*Sciences et Techniques de l'Eau* 1994, **27**, No 3, 55-61 (in French, English summary).

Since 1988 the firm of Premier Enterprises CAN Ltd has been conducting trials on the use of peat-based biofilters for the treatment of sewage of domestic or municipal origin. The results of their experimental programme, consisting of the laboratory stage, the initial development stage (1988-1990) and the pilot plant stage (1990-1993) are reviewed and the principal features of the first generation design are outlined. This comprised a pretreatment stage using a conventional septic tank followed by the biofiltration stage which was composed of 2 peat filter beds arranged in parallel. Dimensional design details, loading rates and performance data for this system are reported both for residential and municipal sewage treatment. Following these the design of several second generation systems as demonstration plants (1992-1995) is outlined, which are sized for family homes of up to 6 residents and a further (3rd generation) packaged design is proposed as a commercial venture registered under the trade name of Ecoflo. This unit is designed to operate without a pump and is suitable for use in remote locations. It was due to become available on the market from Spring 1994 (see also following abstract). (English translation 255 pounds sterling valid for 1995). **Canada**

**95-0429**

### **Implementation of peat-based treatment systems for on-site treatment of domestic sewage in Quebec: state of the art. Part two - Hydro-Quebec's experience.**

*Sciences et Techniques de l'Eau* 1994, **27**, No 3, 55-56 and 61-64 (in French, English summary).

Based on the results of earlier studies, in particular those of the Premier Group of Wolf river, P.Q., the firm of Hydro-Quebec has developed 3 generations of modular, peat-based biofiltration systems for treating the sewage generated at its own hydroelectric plants and their supporting facilities. The 3 successive designs are outlined, the first generation being for seasonal use at 2 isolated locations and with flow rates in the range 1.2 to 18 m<sup>3</sup> per d. The second generation (1991-1993) consisted of 2 permanent installations at 2 power station sites and differed slightly in their detail design, the final effluent was discharged to stream (Mamouquagan river) in both cases. These plants removed 86 per cent of the BOD<sub>5</sub> and 97 per cent of suspended solids on average during filtration through the upper 60 cm layer of peat. A third generation plant was designed for use at the Hull No 1 power station on the Outaouais river and included an upper geotextile filter layer situated above the peat filter bed and was provided with a low pressure perforated pipe distributor for ensuring an even spread of the septic tank effluent at the head of the filter. It was designed with a rectangular cross section for an infiltration rate of 450 litres per m<sup>2</sup> d. No performance data are available (see also preceding abstract). (English translation 160 pounds sterling valid for 1995).

**Canada**

**95-0430**

### **On-site treatment systems for community use: the situation obtaining in Quebec**

J. P. DUBÉ (E. A. L. Environment Inc., Montréal, P.Q.) and R. ROY.

*Sciences et Techniques de l'Eau* 1994, **27**, No 3, 24-31 (in French, English summary).

For communities where no sewerage network is available, some form of alternative sewage treatment system is desirable, usually of the septic tank type, as a method of serving well defined groups of households or single dwellings. So far attention has been principally concerned with on-site treatment systems for single or very small clusters of houses, but further interest has been aroused in the design of community systems and the factors governing the design of these are reviewed. The choice of the most appropriate system design is based on a knowledge of the wastewater flow rate and the site characteristics (soil and water table). The simplest type involves the use of infiltration trenches, beds or mounds where the site conditions are favourable and a minimal depth of 90 cm of unsaturated soil must be ensured beneath the distributor pipes. In other cases intermittent filters may be used, of varying design, although they generate effluent which must be disposed of via suitably designed drainage fields. In all cases there must be provision for preliminary digestion in a septic tank, the entrance to which must be below the tank water level and situated below ground. The effluent must also be conveyed to the disposal site by a pressure pipeline which ensures uniform distribution across the whole of the percolation bed. Various physical configurations for these systems are illustrated and a decision tree is presented as a way of selecting the most appropriate type of system. (English translation 285 pound sterling valid for 1995). **Canada**

## 95-0431

## Direct and indirect water re-use.

CHIFFEY, W.E. WESTERHOFF (Malcolm Pirnie Inc., White Plains, N.Y., U.S.A.)

*Water Supply*, 1994, 12, No 1, 2, IR 91-IR 95

An international overview based on national reports is presented on direct and indirect water re-use. Pressure on water resources, more stringent wastewater discharge requirements and advances in water re-use technology were stimulating increasing water re-use. Indirect re-use often involved discharging treated sewage effluents into rivers from which raw water was subsequently abstracted for potable supply. Alternatively, wastewater treated to high standards could recharge aquifers. Direct re-use involved treating sewage effluent to potable standards. At waterworks, filter backwash water and sludge supernatants could be recycled. Treated domestic wastewater could be used for non-potable purposes in agriculture, industry and recreation. Most water re-use experience came from the U.S.A. where considerable research was in progress. The most common re-use had been non-potable in order to release high quality water for potable purpose. **International**

## 95-0432\*

## Agricultural utilization of sludges and production of biomass transfer of trace metals due to the leaching effect of rainfall

BEAUDEGON, C.E.N. (Grenoble), L. CHARENTIS, J. BERTRAND, D. MARION, F. CROZE, P. COROMPT and K. SARGENTIA

*HYDROTOP 94 Colloque Mieux servir l'eau*, Marseille, Vol. 1, 1994, 17-28, in French, English summary

Field and laboratory experiments were carried out to determine the extent of leaching of trace metals from sludge by rainfall. Six intensive sludge applications to soils in the Gers region aimed at promoting rapid tree growth. Studies were carried out on the heavy metal content *in situ* and also using soil analysis in the laboratory in order to assess the capability of the soil in mobilization of trace metals in the percolating water. In the field, the extent of leaching due to rainfall was determined in the first year, acidified demineralized water applied to metal compounds and a simulation experiment was performed in which the sludge, representing the cumulative load from the application of 334 tonnes per hectare of sludge of 2.34 percent solids over a period was subjected to percolation at a uniform rate of 10 mm per year, annual rainfall at 720 mm per year. The percolate was then passed through 2.5 m columns of sand and charcoal to filter the soil, analysed to determine the degree of mobilization of trace metals of environmental significance: cadmium, copper, chromium and lead. **France**

## 95-0433\*

## Sewage sludges and afforestation in the Mediterranean context

M. M. CADOTON, Societe du Cam de Provence, Centre d'Aménagement de la Région Provence-Aix en Provence, and J. TREMBLEAU, ANCAR

*HYDROTOP 94 Colloque Mieux servir l'eau*, Marseille, Vol. 1, 1994, 357-364, in French

The last 10 year period of experiments concerning the use of sewage sludge as a method of conditioning and enhancing the value of forest soils following the destruction of their tree cover by forest fires in the Mediterranean region are summarized. The approach consisted in testing various rates of application of sludges previously submitted to different extents, on trial plantings of several tree

species indigenous to the Mediterranean district while monitoring their effect on survival and growth rate together with the quality of the percolate and the properties of the soil. Both raw and anaerobically digested sludges were employed following a variety of dewatering and stabilization treatments; the several combinations are summarized and the results presented showing the response of different species, some of which exhibited positive and other negative reactions to the incorporation of sludge. In order to achieve optimal growth among the desired species it was advantageous to delay tree planting for a year following the application of sludge and to allow the development of vegetative cover during the intervening period. The maximal sludge application rate was governed in part by the effects of leaching on the soil/groundwater system but for thermally conditioned sludges a rate of 400 tonnes per ha of sludge solids was admissible although for other types only 100-150 tonnes per ha would be acceptable. **France**

## 95-0434\*

## Heavy metals and sewage sludge spreading

A. GRANDAIS, R. BIAN, Laboratoire Central des Ponts et Chaussées, Bouguenais

*HYDROTOP 94 Colloque Mieux servir l'eau*, Marseille, France, Volume 1, 1994, 365-373, in English

Studies of the behaviour of trace metals in sewage sludges following sludge application to different types of soil (calcareous, loamy or sandy) were performed with the aid of 1 m<sup>3</sup> rectangular concrete lysimeters situated in the open and perspex columns measuring 25 by 100 cm in the laboratory. The laboratory columns were watered at weekly intervals with deionized water in amounts corresponding to the volume of rain water received outdoors. Percolate samples were collected at regular intervals and analysed for a total of 6 metallic elements. Three different sludge types varying in their heavy metal content were employed, originating from the sewage treatment plants for Amboise, Nancy and Achères; the latter type of anaerobically digested sludge representing 30-40 per cent of the total sludge output for France. After 44 months irrespective of the soil or sludge type, the depth of migration of the heavy metal did not exceed 5 cm. Moreover, the cumulative load from the analysis for sludge and soil indicated that immobilization within the soil column occurred with soils. Although the elevated metal concentrations in the uppermost soil indicated that some effects on plant growth might be envisaged. After 18 months, sample collection and analysis of the composition of the percolating water failed to show any evidence of metal breakthrough. Modification of the physico-chemical factors (pH, Eh) could however induce other effects. **France**

## 95-0435\*

## What lies ahead for the agricultural utilization of sewage sludge?

D. ANDRIEU, SEDE, Boumiers

*HYDROTOP 94 Colloque Mieux servir l'eau*, Marseille, Volume 2, 1994, 458-464, in French, English summary

The disposal of sewage sludge in France by controlled agricultural spreading is briefly reviewed in view of the existing disposal options and the ban on disposal to landfill which is expected to come into force by the year 2002. The total sludge production is 600 000 tonnes per year (dry weight) and at present 50 per cent of this is used in agriculture although only a fraction of this amount is subject to detailed controls regarding its application. Some of the constraints affecting the utilization of sludge are discussed including the limiting values in respect of heavy metal contents according to the AFNOR stipulation and the more stringent EC Directive together

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with the difficulties due to its physical properties. Treatments designed to render it more readily acceptable include lime treatment, composting and drying but further inducements are needed to encourage a greater extent of agricultural utilization in the future. The advantages and disadvantages associated with various forms of sludge are presented in a chart indicating those places in France where the different forms of treated or partially dried sludge are produced with a view to agricultural utilization. **France**

95-0436\*

### **Multipurpose installation for beneficial agricultural utilization of sewage sludges and vegetable waste at Ensues, French Riviera.**

M. CUCCHI (Société Biotechn. Marseille) and C. NERVAL. *HYDROTOP 94 Colloque Mieux gérer l'Eau Marseille* Vol. 2, 1994, 450-457 (in French, English summary).

The utilization of sewage sludge by composting in conjunction with vegetable matter (green plant residues) at the Ensues composting station is discussed. In the area concerned along the Mediterranean coast there is little opportunity for sludge disposal by spreading onto cultivated soils in liquid form, whereas by a controlled admixture with vegetable waste followed by aeration and spreading in thick layers above a slatted floor, an aerobic decomposition process is promoted (assisted by an extraction fan) which enables foul odours to be eliminated. Any liquid draining from the mixture is collected and after maturation for 4-6 months, a product is obtained which is free from undesirable bacteria or odours and is readily spread onto cultivated soil. The product contains 56 per cent solids, with total nitrogen of 2.4 per cent, total phosphorus of 3.5 per cent and total potassium of 0.7 per cent and relatively low levels of heavy metals. Should there be an outlet for sludge in the original form, the loader and the agricultural tractor employed in the composting process can be used to load and transport the sludge to a nearby cultivated site. **France**

95-0437\*

### **Co-composting of sewage sludges and park waste**

Y. JOMIER (ORVAL, Nantes) and D. HILAIRE. *HYDROTOP 94 Colloque Mieux gérer l'Eau Marseille* Vol. 2, 1994, 472-480 (in French, English summary).

The operation of the Arc-en-Ciel (Rainbow) project for co-composting of sewage sludge with park and garden refuse from the city of Nantes (population 500 000) is described. The operation was carefully planned to ensure that an acceptable product suitable for use as a soil conditioner was obtained by applying effective controls to the composting process, principally the preliminary combination of the plant refuse, with its high content of lignocellulose, to encourage microbial attack, and admixture with sewage sludge to provide a relatively homogeneous, permeable mass with a carbon/nitrogen ratio adapted to the action of the necessary micro-organisms. The composted mass was stored under cover for several months as part of a maturing process and was screened prior to use. An air extraction system was fitted to the compost storage building to prevent unpleasant odours from escaping to the surroundings. The project handles around 6700 tonnes of sludge per year, the optimal moisture content for composting being 20 per cent, while 10 000 tonnes of plant debris per year was utilized, this being subjected to a rigorous inspection and selection process to eliminate foreign matter before use. **France**

95-0438\*

### **Incineration of sludge in a fluidized bed furnace.**

J. JAROSZ (OTV, Courbevoie). *HYDROTOP 94 Colloque Mieux gérer l'Eau Marseille* Vol. 2, 1994, 466-479 (in French).

The advantages of using modern sludge incinerators of the fluidized bed type for the disposal of sewage sludge from large municipal sewage works are emphasized in view of the latest improvements in design and control systems. The design of the furnace is discussed, consisting of 3 principal parts, namely the air intake manifold, the hearth on which is supported a bed of sand maintained at 750°C and the combustion chamber. Methods for controlling the feed rate as a function of the conditions inside the furnace are described, the centralized control system being the uXL package from Yokogawa. Other important considerations involving the composition of the exhaust gases and the scrubbing treatments essential to reduce atmospheric emissions within permissible limits are also discussed, as are the fate of heavy metals and the variation in heavy metal contents for sewage from sewage treatment plants with different rated capacities. For the majority of metals their concentration increases with the size of the plant owing to the contribution from industrial or other non-domestic sources. **France**

95-0439

### **Hearth of the matter**

*Water & Environment International*, 1994, 3, No 30, 28 and 30. Pyrolysis/incineration (starved air combustion) of sewage and industrial sludges could offer improved combustion, reduced flue gas volume, lower dust carry-over levels and increased thermal efficiency. The NE-SA process uses the traditional Nichols-Herresholt multiple hearth furnace with the addition of 2 ducts equipped with slide gates and incorporation of several inlets for combustion air. Process operation and performance is discussed. Commercial applications of the process are described. The robust incineration conditions provided easier process set-up and operation. Furnace temperatures could also be readily controlled to prevent sintering. **Belgium**

95-0440

### **Supercritical water oxidation - the final solution for the destruction of sewage sludge**

*Water & Waste Treatment*, 1994, 37, No 9, 32 and 42. Design of a flameless combustion system. Supercritical Water Oxidation (SCWO) process is briefly described. Operation of a plant in Germany for the treatment of pharmaceutical wastes containing up to 40 000 mg COD per litre is reported. Products of the process include carbon dioxide, water, sulphate, phosphate, nitrogen and insoluble metal oxides. Oxidation rates in supercritical water are faster than under subcritical conditions and oxidation proceeded almost to completion. Automatic control systems for belt presses are briefly considered. **U.K.**

95-0441

### **Treating a million tons of sludge**

*Water & Waste Treatment*, 1994, 37, No 9, 38. Design and construction of the Colehill (Severn-Trent Water) sewage sludge incineration works is briefly described. When fully operational in 1995 the works will have the capacity to treat 5 tonnes dry solids per h using 2 Fluidfo fluidized bed incinerators. Treatment of fumes and sludge wastes are considered. **U.K.**

## INDUSTRIAL EFFLUENTS

See also Abstracts 95-0022, 95-0026, 95-0440

95-0442

**Pervaporation technology: fundamentals and environmental applications.**

J. A. BARBER (Hoechst Celanese Corp., Charlotte, N.C.) and B. D. MILLER

*Chemical Engineering*, 1994, 101, No 9, 88-90

Pervaporation technology had recently been adapted to remove volatile organic compounds (VOC) from wastewaters. Membranes were typically polymer composites. Performance varied depending on the chemical properties of the feed stream and the membrane's characteristics. The development of spiral wound modules provided an improvement to pervaporation technology. Case studies illustrate the use of pervaporation for removing methyl ethyl ketone, benzene and trichloroethylene. Where high purity was required, pervaporation could be combined with conventional treatments, such as activated carbon adsorption, anaerobic biological treatment, steam stripping, or oxidation. Pervaporation systems offered flexibility in operating across a wide range of process conditions. They were simple to operate and easy to maintain. U.S.A.

95-0443

**Purification of industrial effluent using granular activated carbon and reactivation**

J. HAMERLINCK (Chemviron Carbon, Brussels)

*Water & Separation*, 1994, 31, No 6, 635-641

Working and design considerations concerning activated carbon treatment systems for liquid effluents contaminated with organic materials are discussed, and include an initial assessment of the complete isotherm for the carbon-liquid phase system under consideration. Various adsorber system configurations are available, including fixed beds in series, moving beds, fixed beds in parallel, fluidized beds, and these are reviewed in terms of their strengths and weaknesses. Reactivation of the granular carbon may be achieved by oxidation in either multiple hearth furnaces or rotary kilns, depending on the carbon exhaustion rate and the weight of carbon part of the carbon. Consideration is also given to handling of carbon after it has been exhausted, and to the respect landfilling is not a viable option due to its cost and environmental implication. Belgium

95-0444

**Alternative strategies for meeting stringent effluent guidelines**

W. W. ECKENFELDER (Eckentelder Inc., Nashville, Tenn.)

*Water Science & Technology*, 1994, 29, No 8, 1-7

The challenges to the chemical and petrochemical industries arising from stringent effluent guidelines for volatile organic carbon (VOC), thermotoxicity and priority pollutants are discussed. For VOC, the biodegradability and the amount stripped in aeration plants could offset a change in equipment if loss to the atmosphere needed to be controlled. Temperatures above 37°C tended to cause poor activated sludge sedimentation. This had to be balanced with priority pollutant removal, which was favoured by high temperatures and high sludge age. Soluble microbial products which were not biodegradable could be produced, rendering effluents toxic. Filtration through granular activated carbon was often the most practical solution. Toxicity to biodegradation could be alleviated by adding powdered activated carbon. The residual hard organic materials remaining in these industrial

effluents often meant that the COD concentration was 10-20 times that of the BOD. U.S.A.

95-0445

**Factors influencing biogas production during full-scale anaerobic fermentation of farmyard manure.**

B. SARAPATKA (Palacky University, Olomouc)

*Bioresource Technology*, 1994, 49, No 1, 17-21

The causes of non-uniformity in year-round biogas production and measures for minimizing these fluctuations in both the transitional and winter periods were examined for farmyard manure that was fermented in airtight digesters for a 30-d period. In general, the factors that affect biogas production fall into 3 different groups: factors that are independent of the operational conditions, factors that may be affected by the operation conditions, and secondary factors such as feed quality, bedding quality and quantity, and manure removal technology. The annual biogas production rate was 0.9 m<sup>3</sup> per large animal unit/d with 3 different production levels being apparent during the summer, transitional and winter periods. Czech Republic

95-0446

**Headspace analysis of malodorous compounds from swine wastewater under aerobic treatment**

A. CHEN (British Columbia University, Vancouver), P. H. LIAO and K. V. LO

*Bioresource Technology*, 1994, 49, No 1, 83-87

Static headspace sampling and gas chromatography were employed to measure the volatile fatty acids (VFA) present as phenol, *p*-cresol, indole and skatole. The aeration procedure adopted involved continuous aeration for 24 h, this being an accepted method for reducing or eliminating odour. The chromatographic analysis was carried out on a Hewlett Packard 5890A automatic headspace sampler attached to a Hewlett Packard 5890 gas chromatograph equipped with a flame ionization detector. Under the aeration conditions examined, the VFA were all degraded down to a zero detectable concentration, although indole was not detected. Canada

95-0447

**Poultry litter and manure contributions to nitrate leaching through the vadose zone**

P. L. ADAMS (Arkansas University, Fayetteville), J. C.

DANIEL, D. R. EDWARDS, D. E. NICHOLS, D. H. POFF and H. D. SCOTT

*Soil Science Society of America Journal*, 1994, 58, No 4, 1206-1211

Experimental plots planted with end use and instrumented with tensiometers, suction cup lysimeters at 60 and 120 cm depths, and pore microlysimeters at 60 cm were treated in summer with poultry wastes. Application of poultry litter at rates of 10 Mg per ha (PL10) and 20 Mg per ha and of poultry manure at 12.7 Mg per ha (PM20) resulted in nitrate-nitrogen concentrations of up to 8, 24 and 17 mg per litre, respectively, at the 120 cm depth. In PL10 plots that received an additional 4.5 Mg per ha poultry litter the following summer and PM20 plots that received an additional 3.8 Mg per ha poultry manure, nitrate-nitrogen concentrations were less than 1 mg per litre at 60 and 120 cm depth, which was below the Arkansas drinking water standard (10 mg per litre at 120 cm). All treatments resulted in increased nitrate-nitrogen concentrations in the vadose zone during winter when consistent downward water movement was observed. Nitrate-nitrogen leaching could be minimized by applying poultry waste in late spring or summer and by following the maximal

## INDUSTRIAL EFFLUENTS

recommended application rate (11.2 Mg litter per ha year) with a single split application (U.S.A.).

95-0448

### Nutrient runoff from pasture after incorporation of poultry litter or inorganic fertilizer.

D. J. NICHOLS (Arkansas University, Fayetteville), J. C. DANIEL and D. R. EDWARDS

*Soil Science Society of America Journal*, 1994, **58**, No 4, 1224-1228

Pasture plots of Captina silt loam soil with 5 per cent slopes were treated with poultry litter (4.5 Mg per ha) or inorganic fertilizer (equivalent to 218 kg nitrogen and 87 kg phosphorus per ha) which were surface applied or incorporated to a depth of 2-3 cm by rotary tillage. After 7 d 50 mm per h simulated rainfall was applied to all plots to produce 0-5 h continuous runoff. Analysis of runoff samples showed that the litter application method had no significant effect on runoff concentration and the mass loss of measured constituents. Nitrate nitrogen and total phosphorus concentrations were significantly higher from inorganic fertilizer treatments (2.6 and 26.1 mg per litre, respectively) than from poultry litter treatments (1.1 and 15.4 mg per litre, respectively). No significant mass loss differences were detected between treatments for total kjeldahl nitrogen (TKN), ammonium nitrogen, total phosphorus and phosphate phosphorus but significantly more nitrate nitrogen was lost from fertilizer treatments. Averaged mass losses of total kjeldahl nitrogen and total phosphorus were 3.8 and 1.7 kg per ha, respectively, which represented 1.3 and 1.9 per cent of applied nitrogen and phosphorus, respectively. Deeper tillage might reduce runoff losses of nutrients but could harm pasture grasses, be expensive to implement and increase soil erosion (U.S.A.).

95-0449

### A comparison of ethanol and methane fermentation of currant- and sulfama-washing wastewater

N. ATHANASOPOULOS (Paris University, Rion)

*Bioresour. Technology*, 1994, **49**, No 1, 93-95

Currant- and sulfama-washing wastewaters, which have a pH of 4.5-4.7 and 0.7-1.5 (5.6-9.3) mg COD per litre, were treated in a fermenter at 33°C with nutrients and commercial baker's yeast as an inoculum for 24 h. The average COD removal was 84 per cent after a single distillation and the average ethanol yield was 0.355 g per g of influent reducing sugars. It is anticipated that an industrial scale application for this process would be economic as compared with methane fermentation and that approximately 2 million litres of ethanol could be obtained from wastewater produced in the Greek dried fruit industry (Greece).

95-0450

### Treatment of palm oil mill effluent by upflow anaerobic filtration.

R. BORTA (UMIST) and C. J. BANKS

*Journal of Chemical Technology & Biotechnology*, 1994, **61**, No 2, 103-109

The loading, which consisted of both diluted and undiluted effluent, was treated in a laboratory scale (23 dm<sup>3</sup> working volume) filter for a period of 215 d at hydraulic detention periods varying from 6 to 15 d and COD levels in the 1.1 to 11.4 kg per m<sup>3</sup> d range. Overall, the substrate removal efficiency was very high (up to 90 per cent), with virtually no suspended solids present in the filter effluent. Typically, the methane concentration in the biogas was about 60 per cent, with the production rate of the biogas being in the range of 20 to 165 dm<sup>3</sup>

per d. Daily biogas production varied from 0.69 to 0.79 dm<sup>3</sup> per g of COD and may be viewed as an additional energy source for use in the palm oil mill. There are 34 references (U.K.).

95-0451

### Anaerobic digestion of malt whisky distillery pot ale using up-flow anaerobic sludge blanket reactors.

J. A. S. GOODWIN (Heriot Watt University, Edinburgh), and J. B. STUART

*Bioresour. Technology*, 1994, **49**, No 1, 75-81

Pot ale, which is a liquid waste, was treated in laboratory scale UASB (upflow anaerobic sludge blanket) reactors inoculated with anaerobic sludge, and the biogas effluent (COD, effluent volatile fatty acids, pH, ammonia, phosphate and suspended solids) were determined. The performance data indicated that diluted pot ale is readily biodegradable using a UASB, while a reasonable COD removal rate may be achieved with undiluted pot ale. It is feasible that UASB reactors could be used to treat malt distillery effluent on an industrial scale, although there is evidence of process instability at higher loadings which would require longer detention periods or higher levels of alkalinity supplementation (U.K.).

95-0452

### Enzymatic removal of selected aromatic contaminants from wastewater by a fungal peroxidase from *Coprinus macrotheca* in batch reactors

E. AL KASSIM (Windsor University, Ont.), K. E. TAYLOR, J. A. NICHI, J. K. BEWERA and N. BISWAS

*Journal of Chemical Technology & Biotechnology*, 1994, **61**, No 2, 179-182

The catalytic capability of *Coprinus macrotheca* peroxidase and horseradish peroxidase was examined relative to phenol, 2-chlorophenol, 3-chlorophenol, 4-chlorophenol, 2,4-dichlorophenol and 4-methylphenol in a mixture of the aromatic compound, the peroxidase and a buffer at the appropriate pH using hydrogen peroxide to initiate the reaction. The microbial peroxidase compared favourably as an alternative to the horseradish enzyme, although aromatic removal was dependent on the amount of the catalyst added since the catalyst had a finite lifetime (Canada).

95-0453

### Considerations in respect of the derivation of two-hourly or half-hourly interval monitoring values from the sewage registers based on annual mean values

W. FLHRIER (Bayer AG, Leverkusen), E. WEIKARD and H. SCHAFNER

*Korrespondenz Abwasser*, 1994, **41**, No 9, 1606-1608 and 1610 (in German, English summary)

Various stipulations in respect of direct discharges from industrial plants, all based on Para 7 of the Water Resources Management Act, impose maxima for the pollution loads which may be discharged during a specified time. In many cases it is expected that the residual pollution load must not exceed a certain fraction of that contained in the untreated wastewater. The problem of monitoring compliance with such a criterion of treatment performance is discussed in view of the highly variable nature of wastewater composition and the numerous batch processes encountered in the chemical industry. Faced with these problems, a new method for deriving monitoring values (eg action and warning limits) from a time series of observations is proposed, and illustrated with reference to measurements of AOX concentrations in the discharge from 2 large chemical plants discharging to the lower Rhine. Values appropriate to 2 h or half-hour

intervals in the measuring sequence are proposed. (English translation 150 pounds sterling, valid for 1995). (Germany)

## 95-0454

# An inhibition study of the effect of azo dyes on bioactivity of biofilms.

Y. C. FU (Cincinnati University, Ohio), H. JIANG, and P. BISHOP

*Water Science & Technology*, 1994, 29, No 7, 365-372

The interaction of 2 azo dye compounds with biofilms grown in different conditions and the effect of the dyes on biofilm processes were investigated. The compounds produced 2 different responses when present at low concentrations: stimulation of the biomass by acting as an energy source, causing an increase in the respiration rate, and inhibition of biofilm activity. The total organic removals (80-85 per cent) was the same whether the dyes were present or not. Though the intrinsic reaction rate declined when dyes were added, the dye AR14 was removed from reactors when present at a concentration of 25 mg per litre. AOT did not affect biofilms from reactors fed primary substrate only, but was toxic to biofilms from reactors previously fed AR14. (U.S.A.)

## 95-0455

# Neutralization of acid water in the chemical industry with limestone

F. G. PLESSIS (SIR, Pretoria) and J. P. MARITZ

*Water Science & Technology*, 1994, 29, No 8, 93-104

The neutralization of acid waters with a fluidized bed of limestone was investigated in batch and semi-continuous laboratory reactor, to evaluate the effect of contact time, cations, iron(III), oxidation and suspended solids. Limestone in the 0.6-1.4 mm size range was used. A contact time of 5 minutes was necessary for effective neutralization to occur with iron(III)-rich water of acidity 4000 mg/litre. Iron(III) and aluminium slowed the rate of neutralization by 4 and 5 times, respectively, compared with iron(III). The reduction was explained by the formation of inorganic complexes. Compared with physico-chemical processes, neutralization with limestone was more effective, required no accurate dosing, no dissolution of limestone at pH 7, and the material was easy to handle and store. (South Africa)

## 95-0456

# Wastewater treatment and integrated environmental protection at the BASF AG in Ludwigshafen, Germany

F. F. STROTMANN (BASF Aktiengesellschaft, Ludwigshafen) and W. WEISBRODT

*Water Science & Technology*, 1994, 29, No 8, 185-192

The separation of cooling water and process effluents contributed to efficient wastewater management at a large chemical complex. A cooling water was continuously monitored for contaminants before discharge to the Rhine river. Up to 600 million litre of process water per day was treated in oxidation ditches with BOD and COD removal of 98 and 88 per cent, respectively. A 200 litre pilot plant was continuously operated on the same wastewater to detect toxic effluents. Minimization of waste production and energy use were emphasized. More attention was to be given to transfer of pollutants between media. Examples of waste minimization principles are illustrated by reference to the production of hydroxylamine and ethylene oxide, oxidation of o-xylene, precipitation of heavy metals, reduction of nitrogen in wastewater, and the elimination of chlorinated compounds from a wastewater. (Germany)

## 95-0457

# Treatment of high strength, and complex and toxic chemical wastewater: end-of-pipe best available technology' vs. an in-plant control programme

S. HELLKIN (Ben-Gurion University of the Negev), A. BRENNER, A. HELLER, and A. ABELIOVICH

*Water Science & Technology*, 1994, 29, No 8, 221-233

Two contrasting approaches to the treatment of a complex, chemical wastewater from an industrial plant effluents were assessed by standard analyses and the Microtox toxicity test. Aerobic biodegradation, volatilization and carbon adsorption were assessed for each individual waste. Anaerobic digestion followed by sequencing batch activated sludge with or without powdered activated carbon were the most successful processes for the whole effluent. The principal factory effluents were examined in detail to isolate degradable, volatile and problematic components so that the bulk of the effluent could be treated by conventional activated sludge processes and the more difficult streams by such processes as air stripping. The approach was feasible. Full technical and economic comparisons would soon be possible. (Israel)

## 95-0458

# Effects of operation conditions on advanced COD removal in activated sludge systems

F. FRANK (Munich Technical University, Garching), P. A. WILDERER, K. MIKSCHE, and V. SYKORA

*Water Science & Technology*, 1994, 29, No 7, 189-197

Factors affecting the composition and concentration of residual organic in the effluent from biological wastewater treatment systems were investigated in sequencing batch reactor experiments. Parameters were varied which had an effect on the experiments. Initial results suggested that bulking was an important factor. A higher sludge age led to the elimination of carbohydrates and compounds in the effluent, though the effluent COD remained almost the same. The duration of the starvation period in each cycle was also important. High substrate removal was only achieved when the duration of the aeration phase was extended so that the enzyme activity was reduced to the background level. (Germany)

## 95-0459

# Decolorization of reactive azo dyes by transformation with

*Pseudomonas luteola*

T. E. HU (Coryell University, Taichung)

*Bioreactor Technology*, 1994, 49, No 1, 47

*Pseudomonas luteola* was isolated from an activated sludge system from a tanning wastewater treatment and was used to decolorize reactive azo dyes, such as Red G, RBB, KP2B and V2RP. After shaking incubation for 48 h, *P. luteola* removed 10% colour from these dyes, during a further 24 h of static incubation. The decolorization efficiencies were 37.4, 43.1, 92.4 and 88 per cent, respectively. The results suggest that reducing the nitrogen concentration did not enhance colour removal even if the high azo dye concentrations examined, and that the colour removal mechanism was different from that of *Phanerochaete chrysosporium*, and may be due to the structural alteration of the chromophore azo group. (Taiwan)



## INDUSTRIAL EFFLUENTS

95-0460

### Recycling of wastewaters from textile dyeing using crossflow membrane filtration.

C. F. NIELSEN (Union Filtration A/S Nakskov)

*Filtration & Separation*, 1994, 31, No 6, 593 and 595

Union Filtration has supplied a small scale pilot plant to a Danish dye works using triazine and vinylsulphone dyes plus the normal degreasing and dyeing chemicals. Typically the effluent stream contained 20-3500 mg COD per litre and a dye load of 700 mg per litre after the dyeing process. Two spiral type nanofiltration membrane modules were incorporated in the system since these have a high COD and dye retention capability. Trials were carried out across the 30 to 900 range and the dye retentions were of the order of 98.7-99.7 per cent for Marine Blue, Red and Yellow dyes. This excellent performance has resulted in the installation of a fully automatic pilot plant with 6 spiral modules giving a total of 36 m<sup>2</sup> of membrane area for the whole plant. **Denmark**

95-0461

### Experimental approaches for the characterization of a nitrification/denitrification process on industrial wastewater.

G. BORTONI (ENEA Bologna), J. S. CECCHI, G. GERMILLER, BIANCHI and A. TUCCHI

*Water Science & Technology*, 1994, 29, No 7, 129-136

The feasibility of the removal of nitrogen from a mixed textile and municipal wastewater was investigated at laboratory scale. Textile and municipal wastes were present in the ratio 4:1. Treatment was carried out in 3 modified Ludzack-Ettinger bench scale units. The characteristics of the wastewater and process kinetic constants were evaluated experimentally. A long sludge age was necessary to overcome the effect of some wastewater compounds which were inhibitory to nitrification and an experimental approach like that adopted was necessary to arrive at a reliable full scale design. **Italy**

95-0462

### Magnetic wastewater treatment in the US chemical industry.

E. J. de REUVER (EnviMag BV, Nijmegen)

*Filtration & Separation*, 1994, 31, No 6, 605 and 607

The EnviMag system is based on the principle of fine magnetizable magnetite particles adhering to the pollutants which are then removed from the wastewater stream with a magnet. This magnetite is then recovered and recycled within the process. A magnetic force that is approximately 1000 times that of the force of gravity is used in the system. In a case study, the EnviMag system was used to treat wastewater containing copper at concentrations of between 1000 and 3000 ppb at a flow rate of 150 m<sup>3</sup> per h. Copper concentrations below 20 ppb were obtained using the EnviMag system and easily met the U.S. EPA limit of 40 ppb. An advantage of this system is the extremely low space requirements and the considerably higher water velocities. **Netherlands**

95-0463\*

### The study of high concentration surfactant wastewater treatment.

X. JIN (South China University of Technology, Guangzhou) and W. XIAO JIN

*HYDROTUP 94 Colloque: Meux gérer l'Eau, Marseille*

France, Volume 2, 1994, 516-520 (in English)

A process for the decomposition of high strength organic wastewaters originating from a cosmetics factory and exhibiting severe foam formation together with a COD ranging from 16,000 to 36,000 mg per litre was developed on the basis of laboratory tests. The basic

constituent a synthetic detergent of the AFS type was not readily degradable but from the results of laboratory tests, a sequence comprising pH adjustment, flocculation with a special hydroxylated polyacrylamide, acid hydrolysis and aerobic biological decomposition giving a satisfactory effluent quality, was devised. Following this process the COD was reduced to 300 mg per litre or less and the BOD to 60 mg per litre allowing discharge to the municipal sewer. **China**

95-0464

### Study of hospital wastewater with reference to the Freiburg University Clinic.

S. GARTISER (Hydrotox Labor für Ökotoxikologie und Gewässerschutz GmbH, Freiburg), E. BRINKER, A. UHL, R. WILHELM, D. KUMMERER and E. DASCHNER

*Korrespondenz Abwasser*, 1994, 41, No 9, 1618-1620 and 1622-1624 (in German, English summary)

In the context of a research project sponsored by the Federal Ministry of the Environment, samples were obtained on 23 occasions from 4 different wastewater generating sections of the Freiburg University Clinic. The samples were 24 h combined samples in each case and they originated from the medical department, the kitchens, the laundry and laboratories. Their characteristics were determined and evaluated in view of the maximal permitted values specified for indirect discharges. From the results obtained to date, clinical effluents frequently exceeded the maxima for AOX compounds, although the origin of these substances was not immediately detectable. From tests with luminescent bacteria and *Daphnia* evidence of toxicity was obtained for several samples and for one sample from each of 3 departments (medical, kitchens and laboratories) there were indications of mutagenicity based on the Ames test or chromosomal abnormalities. Further studies will include chlorine or hydrogen containing medicines and disinfectants in order to elucidate the source of the elevated AOX contents. (English translation, 1990 pounds sterling valid for 1995). **Germany**

95-0465

### Trending of pharmaceutical water systems - a customer-oriented process.

D. C. SINGH (SmithKline Beecham Pharmaceuticals, King of Prussia, Pa.)

*Ultrapure Water*, 1994, 11, No 6, 18 and 20-21

Practical advice is offered on how to set up and operate a system for monitoring and reporting trends in the microbiological quality of pharmaceutical grade water. The first essential is to define who in the factory needs to know what and why. This will determine the effort spent on monitoring and generate a programme of maintenance for the several processes once the likely sites of departures from the acceptable have been identified. The data collection element of the system should be supplemented by meaningful presentation to those who will use them; this may entail incorporating special features (such as alerting a specific user to values which are approaching the limit of tolerance for his particular process). It is considered essential to obtain feedback from data users in order to refine the monitoring programme to the point where it collects only relevant data but collects and presents those as thoroughly as possible. **U.S.A.**

95-0466

**The treatment of chromium wastewaters using the sorptive potential of leaf mould.**D. C. SHARMA (Birmingham University) and C. F. FORSTER. *Bioresour. Technology* 1994, 49, No 1, 31-40.

The sorption of hexavalent chromium(VI) which is a priority pollutant as defined by the US EPA and other authorities, was examined using well rotted leaf mould. Kinetic studies indicated that the leaf mould is a potential sorbent for hexavalent chromium, and that the optimal pH was 2.0. At this pH level, the maximal removal efficiency was 8% per cent at a hexavalent chromium dose of 32 g per litre. Other materials such as activated carbon, sphagnum moss peat and compost exhibited a much greater adsorption potential than was the case for leaf mould in terms of capacity and adsorption reaction rate. In turn, leaf mould was superior to other materials such as sawdust and coconut husk fibres, but an important factor is the availability of materials for such applications. **U.K.**

95-0467

**Full scale treatment of phenolic coke coking waste water under unsteady conditions.**J. SCHUKA (Institute for Ecology of Industrial Area Kattowice), J. MOREL, S. MIERZWIŃSKI and R. JANIUSZAK. *Water Science & Technology* 1994, 29, No 8, 69-76.

The ammoniacal and process wastewaters from the largest coking plant in Poland were treated by grit removal, flocculation, coagulation, sedimentation, flow balancing and activated sludge. Domestic wastewaters were introduced at the balancing stage, supplementing the phenols was added to the aeration tank. Strengths of COD, ferrous and thiocyanate, which fluctuated hourly, had risen substantially over years. An optimal ratio of ferrous salt congruent to COD of 0.05 removed 20-25 per cent of COD at a pH above 8. Some iron was added to the aeration stage, and although this was not intended, it was beneficial to sludge density. Following successful trials, the activated sludge by dissolved air flotation, before the activated sludge stage was to be introduced. The aeration units were designed to accept an organic load of 0.9 g COD per g mixed liquor suspended solids per day. Although the variation was much greater, biological treatment was satisfactory. Further treatment with ferrous chloride and potassium dichromate completed the processes. Improvements to the design of the balancing tank were desirable. **Poland**

95-0468

**Evaluation of treatment efficiency of processes for petroleum refinery wastewater.**K. K. CHIN (Singapore National University, Kent Ridge). *Water Science & Technology* 1994, 29, No 8, 41-50.

The efficiency of stages in the treatment of refinery wastewater was investigated at one site by daily monitoring. Treatability studies were carried out in laboratory activated sludge units. The oil separator removed much of the settleable solids and oil, reducing mean oil and grease concentrations from 7220 to 550 mg per litre. Coagulation with alum, lime and polyelectrolyte followed by dissolved air flotation reduced this to 145 mg per litre, at which point the COD was 170 mg per litre. Extended aeration with a hydraulic retention time of 15 d further reduced the COD to 378 mg per litre. BOD was only 18 mg per litre, indicating the considerable biologically hard residual in the effluent. Improvements to the treatment processes were required. **Singapore**

95-0469

**Waste minimization promotes biophysical treatment of complex petrochemical wastes in Israel.**

A. LIEBER, Invivocon International Ltd, Fullerton, Calif, U.S.A., and A. RAVEH.

*Water Science & Technology* 1994, 29, No 8, 201-208.

A 300 m<sup>3</sup> per d petrochemical effluent was treated after oil skimming and pH adjustment in an oxidation plant employing powdered activated carbon and mixed liquor solids above 10,000 mg per litre, the former's concentration being maintained constant. Waste activated sludge was thickened and pressed to a cake of 40-50 per cent COD removal was 95 per cent over the first 2 months of operation. The final effluent satisfied soluble BOD and total suspended solids limits of 30 and 60 mg per litre, respectively. The system was supported by waste minimization which eliminated relatively unpolluted water. **Israel**

95-0470

**Biologically resistant contaminants, primary treatment with ozone.**

D. F. FUCHIGARAY (White Martins Gases Industriais do Nordeste SA, Salvador, BA) and R. F. OLIVEIRA.

*Water Science & Technology* 1994, 29, No 8, 257-261.

The pre-treatment of petrochemical wastewater by ozone generated from commercial oxygen was studied in the laboratory. Low molecular weight hydrocarbon concentrations were determined by gas chromatography and ozone by UV absorption. In some experiments, pentachloride were included in the ozone contact column. Benzene, ethylbenzene and toluene were reduced by almost 100 per cent. The organic matter in another effluent was transformed to more biodegradable compounds. Process efficiency depended on wastewater composition and concentration. **Brazil**

95-0471

**Ecotoxicology of waters under the influence of a petrochemical complex.**

R. NOLE (CORSAN STEEL, Trinito RS), A. ZANDONAI and M. A. RIES.

*Water Science & Technology* 1994, 29, No 8, 79-90.

The regular monitoring and studies carried out on effluents from a petrochemical complex are described. Organic wastes were subjected to primary and aerobic secondary treatment, mixed with municipal wastes and distributed to 8 tertiary stabilization ponds. The final effluent percolated into the soil. Conventional chemical tests, plant species, underground and surface water quality, toxicity tests on algae, invertebrates, in fish at various stages, and bacterial counts were undertaken. Such tests helped to minimize the effects of the discharge on the immediate environment. **Brazil**

## EFFECTS OF POLLUTION

95-0472

**Oestrogenic substances in water - a review.**J. K. LAWELL (WRc plc, Medmenham) and M. J. WILKINSON. *Aqua* 1994, 43, No 5, 219-221.

The possible effects of oestrogenic substances in rivers arising from sewage works on fish and humans through drinking waters of surface origin are reviewed. Some evidence of hermaphroditism in fish taken from rivers with a high sewage effluent content, and the production of vitellogenin in male rainbow trout were suggestive, but inconclusive.

## EFFECTS OF POLLUTION

sive, the protein was normally found only in mature female fish. The reasons for an apparent increase in testicular cancer in humans, lower sperm counts and abnormal sperm remained obscure. Diet, life style, stress and environmental pollution could be factors. The lack of homogeneity of drinking water suggested it was only a minor cause of a widespread phenomenon. U.K.

95-0473

### Effect of pollutants on survival of *Escherichia coli* in microcosms of river water.

S. P. PATHAK (Industrial Toxicology Research Centre Lucknow) and J. W. BHATTACHARJEE

*Bulletin of Environmental Contamination and Toxicology* 1994, **53**, No 2, 198-203

The effect of aquatic pollutants on the survival of various strains of *Escherichia coli* in microcosms containing less polluted and highly polluted water from the Gomati river in India was investigated. The river passes through the city of Lucknow and receives municipal sewage, industrial effluents and agricultural runoff. *E. coli* strains resistant and non-resistant to metals and antibiotics were used as test organisms. The results confirmed that soluble chemical pollutants adversely affected natural aquatic bacteria. The growth and survival of resistant strains were less affected. The survival of resistant and pathogenic organisms was of importance from a public health standpoint. India

95-0474

### Organochlorine and metal contaminants in baleen whales: a review and evaluation of conservation implications.

L. J. O'SHEA (National Ecology Research Center, Fort Collins, Colo.) and R. L. BROWNIE

*Science of the Total Environment* 1994, **154**, No 2/3, 179-200

Literature on DDT and its metabolites, PCB, other organochlorines and metals in baleen whale tissues is reviewed. Baleen whales comprise the fin whale (*Balaenoptera physalus*), sei whale (*Balaenoptera borealis*), Bryde's whale (*Balaenoptera edeni*), minke whale (*Balaenoptera acutorostrata*), humpback whale (*Megaptera novaeangliae*), gray whale (*Eschrichtius robustus*), bowhead whale (*Balaenoptera mysticetus*), right whale (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*). Concentrations of these contaminants in baleen whales are low and vary with age, sex, region of exposure and feeding habits. Concentrations of total DDT and PCB are higher in the northern hemisphere than the southern hemisphere. The implications for conservation of baleen whales are discussed. Laboratory studies on the effects of organochlorines on direct mortality and impaired reproduction in other mammals are reviewed. There are 148 references. U.S.A.

95-0475

### Diseases and environmental contaminants in seals from the Baltic and the Swedish west coast

M. OLSSON (Swedish Museum of Natural History, Stockholm), B. KARLSSON and L. AHNEID

*Science of the Total Environment* 1994, **154**, No 2/3, 217-227

The results of a project to study the relationship between pollutants and reproductive impairment and disease in Baltic seal populations are described. Studies on historical Baltic grey seal (*Halichoerus grypus*) showed that the prevalence of a disease complex consisting of a primary lesion in the adrenals causing secondary lesions in other organs increased after World War II. This disease was also found in ringed seal (*Phoca hispida*). In 1988, 60 per cent of the harbour seal population (*Phoca vitulina*) along the Swedish west coast and in the

southwestern part of the Baltic died from Phocine Distemper Virus epizootic. Concentrations of 17 metals, DDT, PCB, DDE and PCB methylsulphonates, toxaphene, chlordanes, polybrominated diphenyl ethers, and dioxins were measured in seals. DDE and PCB methylsulphonates played a role in the disease complex affecting Baltic grey seal and ringed seal. There are 38 references. Sweden

95-0476

### Effects of experimental and cultural lake acidification on littoral benthic macroinvertebrate assemblages.

M. STEPHENSON (Freshwater Institute, Winnipeg, Man.) G. MIERLE, R. A. A. REID and G. I. MACKIE

*Canadian Journal of Fisheries and Aquatic Sciences* 1994, **51**, No 5, 1147-1161

The development of methods for assessing and comparing benthic macroinvertebrate (BMI) assemblages, using lakes that were experimentally acidified at the Experimental Lakes Area (ELA) in north-western Ontario are documented. A simple assessment technique based on the presence or absence of taxa at randomly selected stations in 64 lakes in central Ontario ranked the importance of each taxon in each lake on a scale of 0 to 5. The relationships between the BMI assemblages were assessed using nonmetric multidimensional scaling (NMDS) based on Kennel's correlation matrix. Using NMDS, the BMI assemblages of 3 experimentally acidified and 7 reference lakes at the ELA were correlated strongly with lake pH. The BMI assemblage structure of central Ontario lakes was predicted by lake area and sensitivity to acidification and by lake elevation. It was not possible to isolate taxonomic responses to these parameters independently or to specific chemical parameters. Small or acid sensitive lakes supported BMI assemblages different from those in larger or well-buffered lakes. There are 83 references. Canada

95-0477

### Effects of ammonia on sodium balance in juvenile rainbow trout *Onchorhynchus mykiss* Walbaum.

L. D. TWITCHEN (Dundee University) and E. B. FIDDI

*Aquatic Toxicology* 1994, **30**, No 1, 27-45

Juvenile rainbow trout were exposed to ammonia at concentrations of 25 to 600 µg per litre and at pH values of 7 or 8. Sodium fluxes were monitored in the external medium at intervals through the experiments by measuring the concentration of sodium  $^{22}$   $\mu$ Ci of which had been added to each chamber. At pH 7, sodium imbalance increased as ammonia concentrations increased from 1.0 µg per litre. There was unidirectional sodium efflux with no effect on sodium influx. The effects of ammonia at pH 8 were generally less severe than pH 7, which suggests that both ammonia and ammonium ion affected sodium balance. There are 47 references. U.K.

95-0478

### Heavy metals in harbour porpoises from Puck bay in the Baltic sea.

P. SZEFER (Medical Academy, Gdansk), M. MALINGA, K. SKORA and J. PEMPKOWIAK

*Marine Pollution Bulletin* 1994, **28**, No 9, 570-571

Four specimens of the harbour porpoise *Phocoena phocoena* were caught in nets in Puck bay, Poland. The stomach contents were examined to determine their diet. This consisted of bottom fish, semi-pelagic fish and pelagic fish. The animals were dissected and samples of liver, kidney and muscle were analysed for silver, cadmium, copper, manganese, lead and zinc. Generally, the kidney accumulated the highest levels of cadmium, and the liver showed maximal concentrations of silver, copper and manganese. Concen-

trations of zinc were similar in the liver and kidney. Inter-specimen differences were observed, principally concerning lead in the kidneys and silver in the livers. The low hepatic and renal concentrations of cadmium in the harbour porpoises from Polish waters were compared with those from UK, German and Danish waters and with cadmium levels in Dall's porpoise (*Phocoenoides dalli*) from the northwestern Pacific. **Poland**

## 95-0479

# A review of heavy metal and organochlorine levels in marine mammals in Australia

C. KEMPER (South Australian Museum, Adelaide), P. GIBBS, D. OBENDORF, S. MARVANEC, and C. LINGHAUS

*Science of the Total Environment*, 1994, 154, No. 2/3, 129-149

Data from 13 sources in Australia regarding toxic contaminants in marine mammals in Australia are brought together and reviewed. Heavy metal analyses (mercury, cadmium, lead) were performed on sperm whales (*Physeter macrocephalus*), dugongs (*Dugong dugon*), humpbacked pilot whale (*Globicephala macrorhynchus*), pygmy sperm whale (*Caperea marginatus*), *Hydrurga leptonyx* (bottlenose dolphin), *Tursiops truncatus*, *Arctocephalus* spp. Levels of heavy metals are generally low in mammals from Australian waters compared with other parts of the world. Exceptions were high levels of mercury in *Physeter crassidens*, high levels of cadmium in *T. truncatus* from the South Australian gulfs, and high levels of lead in some cetophid species. Very few Australian marine mammal tissues have been analysed for organochlorines. Organochlorines were moderately high in Victorian odontocetes. There was a need for a co-ordinated, in-depth approach to the study of marine mammal chemistry and pathology in Australia. There are 35 references. **Australia**

## 95-0480

# Environmental contamination and marine mammals in coastal waters from Argentina: an overview

E. MARCONI CCHIO (INIDEP, Mar del Plata), M. S. GERPE, R. O. BASTIA, D. H. RODRIGUEZ, and S. G. MORON

*Science of the Total Environment*, 1994, 154, No. 2/3, 141-151

A research programme was implemented in 1985 to study the occurrence and tissue distribution of heavy metals (total mercury, cadmium, zinc, copper) in marine mammal species in Argentinian coastal waters (south western Atlantic Ocean). The results of the programme are reviewed. The Argentinian coastal waters are described and potential sources of pollutants outlined. The studied species were: bottlenose dolphin (*Tursiops geophysus*), La Plata dolphin or franciscana (*Pontoporia blainvilliei*), pygmy sperm whale (*Kogia brevipops*), Caviare's beaked whale (*Ziphius cavirostris*), South American fur seal (*Arctocephalus australis*), and the South American sea lion (*Otaria flavescens*). High levels of heavy metals were found in all studied species. Mercury, zinc and copper accumulated most in the liver and cadmium most in the kidney. The results are discussed with respect to the feeding habits, age, migratory pathways, and sex of the marine mammals. There are 55 references. **Argentina**

## 95-0481

# The specificity of meiobenthic community responses to different pollutant: results from microcosm experiments

M. C. ALSTEN (Plymouth Marine Laboratory), A. J. MELVOY, and R. M. WARWICK

*Marine Pollution Bulletin*, 1994, 28, No. 9, 557-563

Microcosm experiments were conducted to determine the specificity of the benthic community response to zinc, copper and cadmium contamination. Sediment and natural meiobenthic communities were collected from the Lythet estuary (mud with a naturally high organic content) and the Fyne estuary (sand with a low organic content). The sediments were dosed with 3 different dose levels of zinc, copper and cadmium. The meiobenthic communities in cadmium treatments did not differ significantly from the controls. Communities in the copper and zinc treatments differed from the controls and from each other. Nematode abundance was reduced by the copper and zinc treatments. In the mud, zinc was more toxic than copper and the effects of each metal on community structure was different. In the sand, copper was more toxic than zinc but the pattern of change in community structure was similar for both metals. The differences between sediments could be due to the binding of metals on to organic material reducing their bioavailability. **UK**

## 95-0482

# Comparative toxicity of five metals on various biological subjects

A. FARGASOVA (Slovak Technical University, Bratislava)

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No. 2, 317-324

The acute toxicological effects of 5 metals on tubificid worms (*Tubifex tubifex*), *Daphnia magna*, microalgae (*Scenedesmus quadricauda*) and higher plants (*Sinapis alba*) were investigated. The metals studied were: mercury, cadmium, lead, arsenic and chromium. The biological subjects' sensitivity to individual metal was also evaluated. There were statistically significant differences between the sensitivity of *T. tubifex* and that of *D. magna*. The latter was more sensitive to metal ions in all tests than *T. tubifex*. LC<sub>50</sub> values differed were particularly notable. The differences were tabulated and recommendations for hazard evaluation programmes made. **Slovakia**

## 95-0483

# Differences in uptake of inorganic mercury and cadmium in the gills of the zebrafish, *Brachydanio rerio*

A. W. GILYNN (Uppsala University), E. NORRQVIST, and A. MUSENTER

*Aquatic Toxicology*, 1994, 30, No. 1, 13-26

Zebrafish were exposed to 20 nM of cadmium, 100 nM mercury, 203 for 15 to 60 minutes in the presence of calcium or calcium channel blocker. Autoradiography was used to determine the distribution of cadmium or mercury in the branchial epithelium. Cadmium uptake was lower in the presence of 2 mM calcium than 0.1 mM calcium but mercury uptake was not altered. The calcium channel blocker verapamil caused a concentration dependent decrease in cadmium uptake. The uptake of mercury was increased by 150 nM verapamil but not by 250 nM. Cadmium and mercury uptake was decreased in the presence of 1 nM lanthanum and 0.1 mM calcium. Exposure for 24 h to 10 nM calcium, 100 nM mercury, 203 showed that cadmium was taken up in some epithelial cells of the primary filament which had the appearance of chloride cells. Mercury was more evenly distributed. There are 35 references. **Sweden**

## EFFECTS OF POLLUTION

95-0484

**Chronic ecotoxicity of Zn and Pb to the zebra mussel (*Dreissena polymorpha*).**

M. H. S. KRAAK (Amsterdam University), Y. A. WINK, S. C. STUIJFZAND, M. C. BUCKERT de JONG, C. J. de GROOT and W. ADMIRAAL.

*Aquatic Toxicology* 1994, 30, No 1, 77-89.

Zebra mussels were exposed to zinc at concentrations up to 3000 µg per litre or to lead at concentrations up to 400 µg per litre for a 10 week period. The mortality and the filtration rate were monitored throughout the experiment. A decrease in the filtration rate was seen at concentrations above 382 µg zinc per litre and 85 µg lead per litre and for zinc this effect increased with exposure time. The 48 h EC<sub>50</sub> were 560 and 370 µg per litre for zinc and lead respectively but the EC<sub>50</sub> values fell to 131 and 91 after 10 weeks. The mortality increased during the period of the experiment. All concentrations of zinc and lead resulted in increased metal concentrations in the surviving mussels. **Netherlands**

95-0485

**Pollution induced morphometric variation of the opercular plates of acorn barnacles (Cirripedia: Thoracica).**

I. ROYO GILABERT (University College of North Wales, Bangor) and A. B. YUILL.

*Marine Pollution Bulletin* 1994, 28, No 9, 533-540.

The effects of chronic metal exposure on the morphometry of the opercular plates of acorn barnacles (*Elminius modestus* and *Balanus amphitrite*) were investigated. The opercular dimensions of *E. modestus* specimens from Birkenhead, Connah's Quay, Mersey Bridge, Aberystwyth and Pembroke Dock were compared using analysis of variance and principal component analysis. The specimens showed site dependent differences in the dimensions of their opercular plate. Those from Birkenhead and Connah's Quay had larger plates than those of the other 3 sites, possibly due to the poor water quality at Birkenhead and Connah's Quay. *E. modestus* and *B. amphitrite* grown in the laboratory under constant salinity and temperature and increasing copper concentrations (100-1200 µg per litre) also showed differences in opercular plate dimensions. Barnacles exposed to the highest copper concentrations had the largest opercular plates. There are 33 references. **U.K.**

95-0486

**Neuropathology induced by trimethyltin in the central nervous system of the urodele *Triturus cristatus*.**

S. GOZZO (Istituto di Medicina Sperimentale, Roma), G. PERRICCI, L. ANDREOZZI, V. MONACO and F. ROSSIELLO.

*Aquatic Toxicology* 1994, 30, No 1, 1-11.

Newt larvae were exposed to trimethyltin (TMT) at concentrations of 0.75, 1.5 or 3 mg per litre for 2 d. All the larvae exposed to 3 mg per litre TMT died. Surviving animals had pyknotic neurons in the telencephalon, diencephalon, mesencephalon and retina. The effect was more pronounced in those newts which had been exposed to 1.5 mg per litre TMT rather than 0.75 mg per litre. Adult newts were given single intraperitoneal doses of 3 or 12 mg TMT per kg bodyweight. Those given 12 mg per kg doses had a high density of shrunken neurons but very few pyknotic cells. No changes were seen in adults given 3 mg per kg. **Italy**

95-0487

**Structure-toxicity relationships for unsaturated alcohols to *Tetrahymena pyriformis*: 3-alkyn-1-ols and 2-alken-1-ols.**

T. W. SCHULTZ (Tennessee University, Knoxville), T. S. KISSEL and M. TICHY.

*Bulletin of Environmental Contamination and Toxicology* 1994, 53, No 2, 179-185.

The biological response in the *Tetrahymena pyriformis* population growth impairment assay to selected 3-alkyn-1-ols and 2-alken-1-ols was determined. Observed and predicted toxicities were compared and quantitative structure activity relationships (QSAR) were developed for the 2 classes of chemicals. The chemicals tested formed parallel series of 3-alkyn-1-ols and 2-alken-1-ols. Both groups of unsaturated alcohols were modelled using the same QSAR and exhibited a very modest, though consistent, excess toxicity in comparison with that predicted by the baseline non-polar narcosis QSAR for saturated mono alcohols. The magnitude of the excess toxicity was not as great as that reported for acute fish lethality. **U.S.A.**

95-0488

**Pathology and toxicology of beluga whales from the St. Lawrence estuary, Quebec, Canada. Past, present and future.**

D. MARTINEAU (Université de Montréal, Saint-Hyacinthe, P.Q.), S. de GISE, M. FOURNIER, L. SHUGART, C. GIRARD, A. LEGACÉ and P. BELAND.

*Science of the Total Environment* 1994, 154, No 2/3, 201-215.

The carcasses of 45 beluga whales found dead in the St. Lawrence estuary between 1983 and 1990 were examined. Of these 45 whales, 9 were affected by malignant neoplasms and 15 by pneumonia. The digestive system was the most common site affected by malignant tumours. Milk production was compromised in 8 out of 17 mature females. Concentrations of total PCB and highly chlorinated PCB congeners were higher in St. Lawrence estuary whales than in Arctic belugas. Benz[a]fluoranthene adducts were detected in St. Lawrence sediments and beluga whales. The high incidence of cancer in St. Lawrence belugas was possibly caused by benz[a]fluoranthene. There are 100 references. **Canada**

95-0489

**Persistent organochlorine residues in small cetaceans from the east and west coasts of southern Africa.**

A. C. de KOCK (Port Elizabeth Technikon), P. B. BEST, V. COCKCROFT and C. BOSMA.

*Science of the Total Environment* 1994, 154, No 2/3, 153-162.

Organochlorine concentrations in cetaceans from the east coast (Indian ocean) and west coast (Atlantic ocean) of southern Africa were investigated. Cetacean species studied were: southern right whale (*Eubalaena australis*), pygmy right whale (*Caperea marginata*), minke whale (*Balaenoptera acutorostrata*), sperm whale (*Physeter macrocephalus*), pygmy sperm whale (*Kogia breviceps*), dwarf sperm whale (*Kogia simus*), Blainville's beaked whale (*Mesoplodon densirostris*), True's beaked whale (*Mesoplodon murex*), Laysan's beaked whale (*Mesoplodon layardii*), Risso's dolphin (*Grampus griseus*), bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*), Heaviside's dolphin (*Cephalorhynchus heavysidii*), dusky dolphin (*Lagenorhynchus obscurus*). Residues of DDE, PCB and hexachlorobenzene were the most prevalent in the blubber of west coast specimens analysed. On the east coast, bottlenose dolphins had higher overall burdens than common dolphins between 1980 and 1987. The results of similar studies in different parts of the world are tabulated. There are 32 references. **South Africa**

95-0490

**Global contamination by persistent organochlorines and their ecotoxicological impact on marine mammals.**

S. TANABE (Fhime University Matsuyama), H. IWATA and R. TAKU KAWA

*Science of the Total Environment*, 1994, 154, No 2/3, 163-177

The global distribution of persistent organochlorines and their ecotoxicological implications on marine mammals are reviewed. The geographical distribution, behaviour, and fate of organochlorines in the coastal and open ocean environments are considered. The major source of organochlorines is from developing countries in the tropics. The organochlorines are dispersed through long range atmospheric transport and are extremely bioaccumulative. Cetaceans have a large pool of persistent toxic contaminants in their bodies. Female cetaceans showed a decreasing pattern in residue levels after maturity. This was explained by the transfer of organochlorines to their offspring during lactation. Cetaceans retained larger numbers of PCB isomers and congeners than other animals due to their low capacity to metabolize a group of PCB isomers with adjacent non-chlorinated meta and para carbons in biphenyl ring. There are 46 references. **Japan**

95-0491

**Toxicokinetics of chlorobiphenyls and associated physiological responses in marine mammals, with particular reference to their potential for ecotoxicological risk assessment**

J. C. H. REIJNDERS (Institute for Forestry and Nature Research Delft, Burg)

*Science of the Total Environment*, 1994, 154, No 2/3, 229-236

Reproductive and immunological disorders can result from exposure to chlorobiphenyls in marine mammals. These disorders are a result of disturbed endocrine systems. Two sets of indicators are distinguished to evaluate the toxicity of organochlorine residues in marine mammals. These are interactions of chlorobiphenyls with the cytochrome P-450 enzyme system and comparative physical and chemical parameters directly and indirectly obtained via functional bioassays. The differences in the abilities of different marine mammals to metabolize PCB are considered. PCBs can potentially exert toxicity in at least 2 different ways: as parent compounds and as metabolized congeners. The biotransformation capacity can be used to give information on which compound are most likely to be involved in toxic responses. Directly obtained blood parameters (total level of vitamin A, steroid hormones and thyroxine). Indirectly obtained blood parameter include nitrogen and antigen in blood. Proliferative responses of peripheral blood mononuclear cells and natural killer activity. There are 49 references. **Netherlands**

95-0492

**Polycyclic aromatic hydrocarbons in fresh and smoked fish samples from three Nigerian cities**

A. AKPAN (Florence University Italy), M. LOKOVIC and P. DOLARA

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 2, 246-253

Levels of contamination with polycyclic aromatic hydrocarbons (PAH) in fish consumed fresh or smoked in 3 major Nigerian cities were determined. Many Nigerian oil wells were located near breeding and harvesting sites serving the freshwater fishing industry. Smoke curing of fish catches in traditional ovens using freshly cut mangrove wood as fuel increased the burden of PAH in the fish as a result of partial charring and smoke condensates from mangroves containing PAH. Estimates of intakes of benzo(a)pyrene, based on

dietary practices in Nigeria, suggested that PAH might be a contributory aetiological factor partially explaining the incidence of cancers in Nigeria. **Nigeria**

95-0493

**PCB congeners in tissues of European otter (*Lutra lutra*)**

C. E. MASON (Essex University, Colchester, U.K.) and J. R. RATHFORD

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 4, 548-554

Samples of liver and brain tissue and scats from several otter (*Lutra lutra*) populations in Ireland, England and Denmark were analysed for PCB congeners using gas chromatography with electron capture detector. Twenty four congeners were recorded and the most abundant were HPAc numbers 163, 153, 168 and 170 which each contributed at least 10 per cent of the total. The sum of PCB in the brains of Irish otter samples was only 11 per cent that of livers and in relation to liver samples penta- and hexa chlorobiphenyls were generally over represented and hepta- and octa chlorobiphenyls were under represented in brain samples. Scat samples tended to contain proportionally more penta chlorobiphenyls than liver. Scats from eastern England contained significantly higher proportions of congeners 105, 118, 157 and 165, a significantly lower proportion of congeners 101, 110 and 149 and higher overall PCB concentrations. Allocation of the percentage of total PCB congeners to 4 environmental priority groups indicated that the most environmental threatening compounds constituted 58-8 per cent of the sample. More detailed congener specific studies of otters and their prey were needed. **Europe**

95-0494

**Abnormally high polychlorinated biphenyl levels in striped dolphins (*Stenella coeruleoalba*) affected by the 1990-1992 Mediterranean epizootic**

A. AGUIAR (Barcelona University) and A. BORRILLI

*Science of the Total Environment*, 1994, 154, No 2/3, 237-24

PCB concentrations and total lipid content were determined in the blubber and liver of striped dolphin (*Stenella coeruleoalba*) affected by the 1990 morbillivirus epizootic in the Mediterranean sea and in striped dolphin sampled in 1987-1989 and 1991. PCB concentrations found in the dolphins that died in the 1990 outbreak were much higher than in healthy dolphins. Three hypotheses are proposed to explain the relationship between high PCB and mortality: depressed immunocompetence caused by PCB leading to an increase in susceptibility to the infection; mobilization of fat reserves leading to increased PCB levels in blood; the formation of a liver lesion capable of increasing susceptibility to infection; previous existence of an unspecified hepatic lesion leading to impairment of the liver function, increases in blood PCB levels, and increased susceptibility to infection. There are 61 references. **Spain**

95-0495

**Comparison of P-4501A1 monooxygenase induction in gizzard shad (*Dorosoma cepedianum*) following intraperitoneal injection or continuous waterborne-exposure with benzo(a)pyrene: temporal and dose dependent studies**

S. L. ELVINE (Miami University, Oxford, Ohio), J. E. ORIS and T. E. WISSING

*Aquatic Toxicology*, 1994, 30, No 1, 61-75

Gizzard shad were given intraperitoneal (i.p.) injections of benzo(a)pyrene (B[a]P) at doses between 0.1 and 50 mg per kg or exposed to waterborne B[a]P at concentrations between 0.14 and

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0.76 µg per litre for 3, 5, 10 or 20 d, and then ethoxyresorufin-O-deethylase (EROD) activity in hepatic microsomes was measured. EROD activity 72 h after i.p. dose was not significantly induced by B[a]P doses of 0.1 or 1 mg per kg, but maximal induction occurred with 10 and 50 mg per kg. Waterborne concentrations of 0.44 and 0.76 µg per litre produced EROD induction, with maximal induction occurring when about 10 mg per kg had been cleared from the water. Maximal induction occurred by day 3 after i.p. injection and after 10 d exposure to waterborne B[a]P. There are 31 references. U.S.A.

95-0496

**Effects of chlordecone on the gonads of freshwater catfish, *Heteropneustes fossilis*.**

A. K. SRIVASTAVA (S.M.M. Town P.G. College, Ballia) and A. K. SRIVASTAVA

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 2, 186-191

The histological changes in the gonads of the freshwater catfish *Heteropneustes fossilis* induced by the pesticide chlordecone (decachloro octahydro-1,3,4-metheno-2H-cyclobuta-pentalen-2-one) were investigated. Chlordecone is widely used to control agricultural pests. The effects of acute, sub-acute and sub-lethal concentrations at different time intervals were determined. Marked degenerative changes in the ovary of the catfish were observed as a result of short and long term exposure to chlordecone. The mechanism by which chlordecone arrested gonadal activity in catfish was associated with impaired nucleic acid (RNA and DNA) synthesis. India

95-0497

**Elimination of diurnal rhythm of respiration by methyl parathion in the crab, *Oziotelphusa senex senex* Fabricius.**

P. S. REEDY (Pondicherry University) and A. BHAGYALAKSHMI

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 2, 192-193

The diurnal variations in oxygen consumption of the freshwater crab *Oziotelphusa senex senex* were investigated. The effect of methyl parathion, an organophosphorus compound, on these variations was then examined. Observed rhythmic variations in oxygen consumption were possibly related to rhythmic variations in locomotor activity. Methyl parathion exposure decreased the respiratory rate at whole animal level and at tissue level. Exposure also disrupted the crab's diurnal respiratory rhythm. This disruption of respiratory rhythm could have a significant effect on the survival of the animal in its normal freshwater environment. India

95-0498

**Chronic histopathological effects of parathion and 2,4-D on female gonads of *Chasmagnathus granulata* (Decapoda, Brachyura).**

F. M. RODRIGUEZ (Universidad de Buenos Aires), M. SCHULTE and I. ROMANO

*Food and Chemical Toxicology*, 1994, 32, No 9, 811-818

Female crabs were exposed to the pesticides parathion (10 µg per litre) and 2,4-D (50 mg per litre) for 2 months during the reproductive period. After this time the gonads of the surviving crabs were dissected out and examined. Parathion appeared to cause an increase in the size of previtellogenic and vitellogenic oocyte size, 2,4-D caused a decrease in vitellogenic oocyte size, and an increase in the number of atretic follicles. Although the assayed concentrations were higher than those usually measured in the environment, high concentrations can occur in sediments, so these pesticides may be a threat

to the reproductive function of aquatic fauna. There are 32 references. Argentina

95-0499

**Acute toxicity of technical trichlorophen to cyprinid fish.**

F. A. ANTON (National Institute for Public Health and Environmental Protection, Bilthoven) and M. ARIZ

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 4, 627-632

The acute toxic effects of the organophosphate insecticide trichlorophen (dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate) on nontarget freshwater fish were assessed *in vivo* by 96-h exposure to concentration ranges of (0.001-400.0) mg per litre technical trichlorophen for *Carassius auratus* and (50-100) mg per litre technical trichlorophen for *Cyprinus carpio*. The calculated 96 h LC<sub>50</sub> values were more than 16-54 mg per litre for *C. auratus* and 92-7 mg per litre for *C. carpio*. Lowest mortality levels resulted from the exposure of *C. auratus* and *C. carpio* to 26-67 and 48-5 mg technical trichlorophen per litre, respectively, and exposure of these species to 150-190 mg per litre and 60-75 mg per litre, respectively, resulted in sublethal effects. Netherlands

95-0500

**Effects of the bacterial insecticide *Bacillus Thuringiensis* var. *kurstaki* (Btk) on a stream benthic community.**

J. S. RICHARDSON (Simon Fraser University, Burnaby, B.C.) and C. J. PIERLIN

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A replicated field experiment in British Columbia was used to test the effects of low (50 BIU per ha) and high (equal to or greater than 5000 BIU per ha) additions of a commercial *Bacillus thuringiensis* var. *kurstaki* (Btk) formulation on a stream benthic community in flow through mesocosms. There were no significant differences in the density or composition of benthos sampled 7 d after Btk application; the densities being highest in the high-dose mesocosm. There were no significant treatment effects on adult emergence. During the 2-5 h treatment, Baetis had marginally elevated drift rates but these differences were negated during the remainder of the 24 h period. Leaf packs lost significantly more mass in controls than in high-dose mesocosms but there were no significant differences in the number of macroinvertebrates on those packs. There was only minor evidence of any effects of experimental application of Btk to a benthic stream community and these effects were not detrimental. Canada

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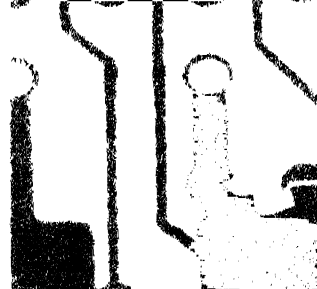
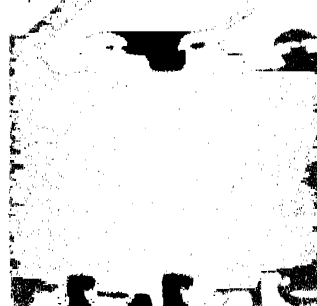
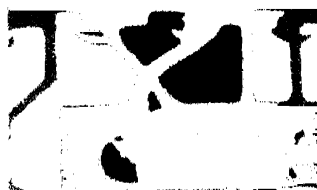
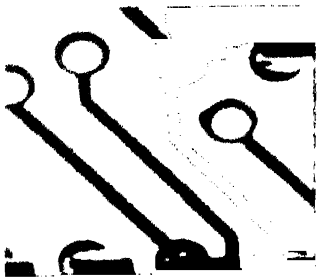
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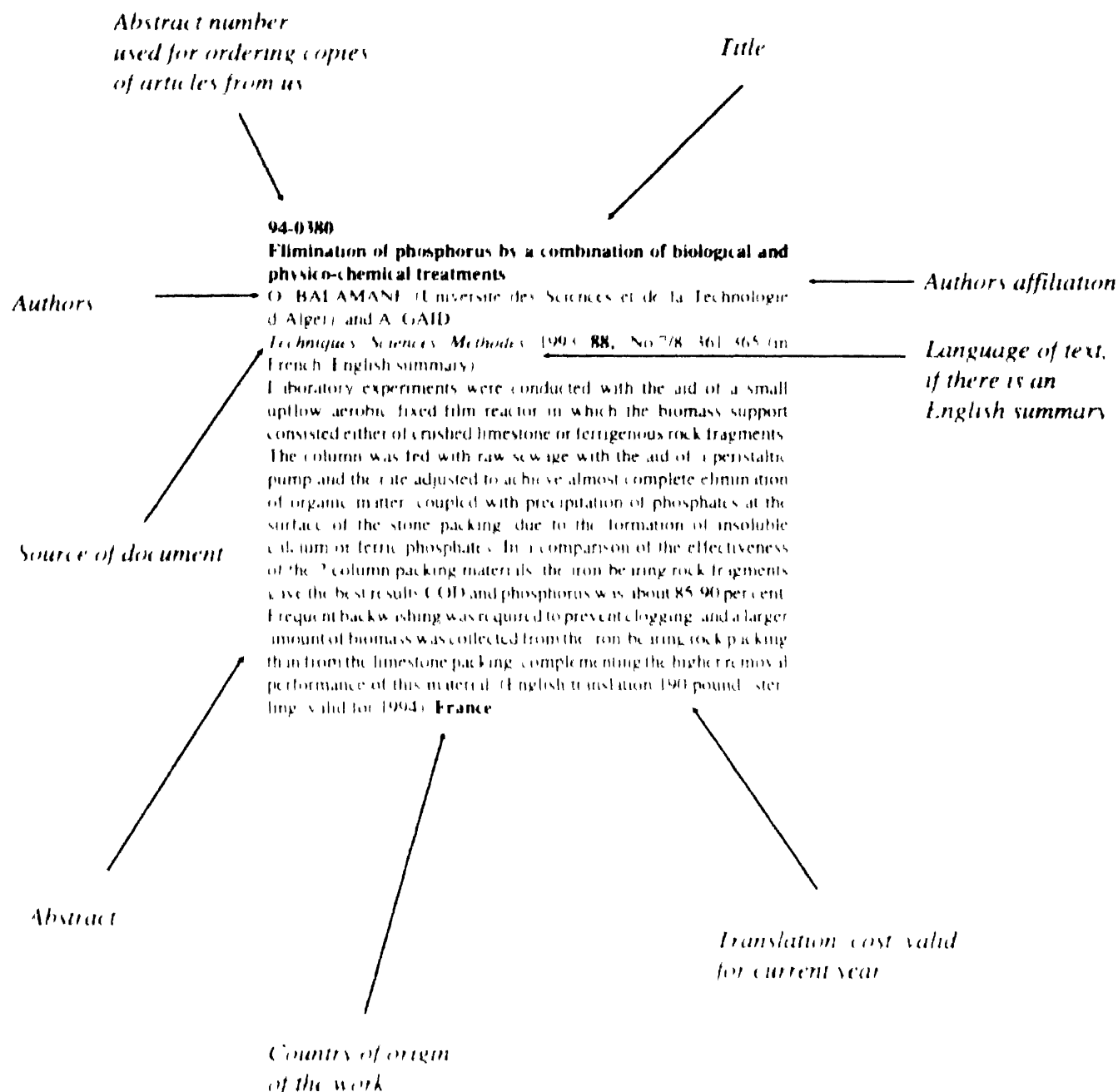


## **Effects of Pollution**

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## WATER RESOURCES AND SUPPLIES

See also Abstracts 95-0607, 95-0610, 95-0612, 95-0692, 95-0694, 95-0765, 95-0844, 95-0846, 95-0850

## 95-0501

### Preview of the international lecture programme of the Pipeline Construction Congress.

D. STEIN (Ruhr Universität Bochum)

*Abwasser-technik* 1994 45, No 5, 4-6 (in German)

The International Pipeline Construction Congress was due to be held in Hamburg from 16 to 20 October 1994 and a synopsis of the papers to be presented is given. The programme was to commence with a seminar organized by the Federal Ministry for Research and Development on the theme of rehabilitation of leaking sewers and the subsequent technical papers were grouped under several headings dealing with methods of detection, microtunnelling, and trenchless pipelaying techniques, maintenance of water supply networks, renovation of sewer pipes under adverse conditions, and new European regulatory controls. In addition to the seminar the proceedings comprised 28 papers concerned with the latest developments in pipelaying, and pipeline rehabilitation, of which 11 were contributed by authors from countries outside Germany. (English translation of pounds sterling valid for 1995) **International**

## 95-0502

### The evolving interface between water quality management and monitoring

W. R. SOLEIMAN (Water Research Center, Cairo, Egypt) and R. C. WARD

*Water International* 1994 19, No 3, 138-44

Various levels through which water quality management in a country like Germany could evolve are examined. Factors to be considered in categorizing management strategies and information needs are discussed. These included planning, financial incentives, research, qualitative, numerical and graphical information. The information needs and monitoring systems for cities, industries and agriculture are standard only strategies, controlling, and evaluation. Innovative assisted strategies are examined. Application of the concept of water quality management in the U.S.A. is described. **International**

## 95-0503

### Developments in industrial effluent control in the United Kingdom

T. J. FISHER (North West Water Limited, Warrington)

*Water Science & Technology* 1994 29, No 9, 1-10

The regulation of industrial effluent discharge to public sewers and controlled waters is explained with emphasis on local enforcement in England and Wales which include: EC Directives, and the International Convention 'Normal Discharge to Sewers', and the British Water Services Companies but any discharge containing dangerous or harmful substances could not be consented without reference to the Secretary of State for the Environment. Discharge to controlled waters are the responsibility of the National River Authority. Additionally, under the Environmental Protection Act 1990, which introduced integrated pollution control, operators of listed processes need consent from Her Majesty's Inspectorate of Pollution before they are allowed to function. Details of legislation, role and definitions, a list of prescribed substances, and in outline of the charging scheme of the 3 regulators are provided. The duties of the regulator and the need for close co-operation between them are noted. **UK**

## 95-0504

### Germany faces future with integrated approach to environmental protection

J. HILDEMEIER (Federal Environment Agency) and B. MEHLHORN

*Water & Wastewater International* 1994 9, No 5, 32-35

This second part of a review of waste water treatment legislation and future trends presents the case for an integrated, holistic approach to pollution prevention. The concept of ecobalancing is discussed in which product specific energy, substance and emission data and the associated toxicological and ecotoxicological effects are considered. The lack of safety data is identified. A combination of separate integrated pollution control and cleaner technologies is proposed to allow a consolidated programme of action incorporating harmonization of existing legislation, integrated enforcement of legislation and authorization procedures and provision of economic incentives (see also Aqualine Abstract No 94-5511). **Germany**

## 95-0505

### Wrestling with reauthorization

E. JAWORSKI (Metall & Eddy, Inc., Laurel, Md.)

*Water Environment & Technology* 1994 6, No 10, 58-63

Difficulties with reauthorization of the Clean Water Act resulted partly from differences in opinion as to the extent of the revision needed. It was agreed that the reauthorization process should address certain issues, such as watershed management, wetlands, and funding. The major elements of the Water Pollution Prevention and Control Act, the Water Quality Act, the draft bipartisan alternative proposal, and the recommendations of the Clinton Administration are summarized. **USA**

## 95-0506

### Congress holds up renewal of water bill

*Water Quality International* 1994, No 3, 9

Some of the additional costs of implementing revisions to the U.S. Clean Water Act currently before Congress for reauthorization are being added with probable cost saving. The U.S. EPA considered that the saving would outweigh the cost, principally as a consequence of simplification of reporting procedures from utilities, offset from benefits anticipated if State-adopted administrative and regulatory proposals for quality regulation on a watershed scale. A major portion of the revision concerns the reduction of nonpoint source compliance costs to utilities to improve their ability to control nonpoint pollution, and the abandonment of the permit cost subsidy. In the current Act for immediate clean up of discharge from point and nonpoint source, some \$800,000 are believed to be allocated to the implementation of a priority for clean up. The cost of cleaning up the point control was put at about 10 million U.S. dollars, whereas the nonpoint control was put at about 10 million U.S. dollars. **USA**

## 95-0507

### The case for discharge permit trading at US reauthorizes Clean Water Act

J. W. FLECK (Eaton University, Urbana, Champagne)

*Water Quality International* 1994, No 3, 16-19

An alternative method of meeting water quality standards for a whole watershed, taking the cleaner portions with the less clean to arrive at a target for the entirety, available to polluting dischargers in the U.S.A., is outlined. In terms of pollution charges taken by government or European polluting emissions exceeded their consent level which, if a uniform standard would be uniformly adopted by all



## WATER RESOURCES AND SUPPLIES

dischargers, give a river quality better than that required by the regulating authority, could sell part or all of his excess provision to dischargers whose treatment fell short. Advantages accrue to both: the offending discharger would be saved the capital expense of installing or upgrading equipment while still contributing financially to overall stream quality, and the seller received an income and had an incentive to install equipment which could cope with the quantities and qualities of potential discharges from new industries. The principal disadvantage is that the system made no attempt to control quality uniformly along the river: locally pollution could be severe. In practice, the idea had not been greatly adopted, by either air polluters or by water polluters: some case studies of the latter are quoted. Congress had to decide whether the practice should be permitted in the Clean Water Act, whose re-authorization was under discussion. U.S.A.

95-0508

### Regulating specific organic substances and heavy metals in industrial wastewater discharged to municipal wastewater treatment plants

H. GRUFTNER (Water Quality Institute, Hoersholm), L. MUNK, I. PEDERSEN and J. TORSLEV  
*Water Science & Technology*, 1994, **29**, No 9, 55-67

New guidelines were developed for regulating the discharge of toxic materials to sewers to avoid inhibiting nutrient removal at sewage works and to enable sludge to be used on agricultural land. The principles underlying the concept focused on the areas to be protected which were the sewerage system, sewer workers, the treatment plant processes, the use of sludge, and the aquatic environment. From these, a series of questions elucidated the fate and effects of substances in varying degrees of detail. Organic substances were classified according to volatility, biodegradability, danger to human health, medium and low aquatic toxicities. Biosorption and bioaccumulation were defined by the octanol/water partition coefficient. Toxic metals were treated in greatest detail. The most important criterion was the quality needed for agricultural disposal and for the aquatic environment. Proposals for general guidelines were calculated with a simple mass balance model combined with water quality criteria and the Danish limit values for sludge used in agriculture.

Denmark

95-0509

### High hopes below the low water mark

L. SUSANI (Environmental Resources Management)  
*Water Services*, 1994, **98**, No 1186, 36-37 and 39

Soon to be implemented within English law, the EC Habitats Directive would enforce coastal protection at national level. The government's discussion papers, *Managing the Coast*, and *Development Below the Low Water Mark*, had encouraged local initiatives and led to the development of Coastal Zone Management and Estuarine Management Plans. These aimed to offer an integrated solution to the conflicting issues of recreation, development and conservation and involved input by various agencies, and public and private bodies. Water companies had been involved in the preparation of coastal plans at various locations. The contributions of South West Water, Northumbrian Water and North West Water are described. U.K.

95-0510

### Environmental legislation in relation to pollution control and the achievement of environmental quality objectives - an overview of recent developments.

G. HILL (National Rivers Authority)  
*Waterline*, 1994, September, 33-49

The many recent changes in environmental legislation relating to pollution control, and concentrates on those developments that influenced discharge of effluents to the aquatic environment. Attention is focused on the Water Resources Act (1991) which defined the statutory duties of the National Rivers Authority in so far as they related to pollution control and also on the Environmental Protection Act (1990) which brought into force the system of Integrated Pollution Control (IPC). Under the 1990 Act, discharges from the most polluting industrial sectors would be authorized by Her Majesty's Inspectorate of Pollution which would issue an authorization using the IPC system which covered releases to water, land and air. U.K.

95-0511

### UK set to get little joy from revised drinking water rules

*INDS Report*, 1994, No 237, 36-38

A draft of an amending Directive on drinking water quality maintained absolute limits for health-related contaminants and the precautionary limit for pesticides. The reduced lead limit of 10 µg per litre would require major expenditure on the removal of lead piping. Some heed had been taken of the U.K.'s demands, with a reduction in the number of parameters and a new procedure to give Member States time to bring water supplies into compliance. Subsidiary compliance reporting, lead, nitrate, nitrite, carcinogens, disinfection byproducts, microbiological standards and PAH are considered.

Europe

95-0512

### Developments in European water policy

T. F. ZABIE (WRc plc, Medmenham)

*Journal of Institution of Water and Environmental Management*, 1994, **8**, No 5, 513-517

EC environmental legislation is outlined under the headings of use-related, industrial sector, and product directive. Likely future developments are considered. Policy was at a crossroads with a new emphasis on sustainable development. Economic instrument, eco-auditing and eco-labelling schemes would help to reduce the effects of processes and products on the environment. The ecological directive, the proposed integrated pollution prevention and control directive, and the revised dangerous substances directive would provide a regulatory framework for the protection of the aquatic environment. Industrial uses of water might be further protected by additional use-specific directives. U.K.

95-0513

### Quality standards for environmental protection: are they the product of scientific argument or merely a manifestation of fear and uncertainty?

H. H. HAHN (Universitat Friedrichiana zu Karlsruhe)

*Korrespondenz Abwasser*, 1994, **41**, No 10, 1734-1736 and 1738-1739 (in German)

The controversy which exists in the public mind with respect to the nature and importance of environmental quality standards is examined and the conflict between standards based on scientific reasoning and those which might be fixed at some arbitrary level owing to lack of hard data or because of political motivation is

highlighted. Three typical situations are examined: the first concerning the discharge of toxic metals such as cadmium into the aquatic environment, where they enter the food chain, possibly with disastrous consequences due to biomagnification. In such cases the use of scientific data is indispensable for establishing limiting values of the specific substance. The second case concerns the discharge of substances for which only limited information is available, but a presumption of toxicity exists. In these situations the use of 'state of the art' methods might be called for to ensure that the load on the environment is reduced to a minimum although the risk associated with the discharge could be quantified. A third case involves the politically motivated setting of certain standards in cases where discharge to a pristine environment is contemplated, and the intention is to prevent any decline in the quality. Examples of all these situations are considered. There was justification for adopting a flexible policy with different approaches based on the knowledge available and the quality of the environment affected. (English translation 235 pounds sterling, valid for 1995). **Germany**

95-0514

**Standards, costs and benefits: an international perspective.**

C. W. M. JOHNSTONE and N. J. HORAN

*Journal of Institution of Water and Environmental Management* 1994, 8, No 5, 450-458

Standards for the discharge of wastewater are considered from the perspectives of the developed world, the developing world and newly industrialized nations. Their setting should be scientifically sound and intended to produce benefits for known costs. Standards in the developed world were often imposed without regard to cost. Their equivalent copying by industrializing and developing nations caused inappropriate technology to be used at excessive costs. This meant there was little political will to enforce standards which were then disregarded. Furthermore, the costs to society of regulation and enforcement were not always appreciated. A phased approach was proposed for industrializing and developing nations so that relevant affordable standards could develop. **International**

95-0515

**Peri-urban water and sanitation.**

D. BENDAHMANE

*Automation Technology* 1994, 21, No 2, 14-16

Some legal and financial difficulties which need to be overcome if Developing World shanty towns are ever to receive adequate public services (including water and sanitation) are examined. The residents, especially squatters, have no ownership of the land they occupied and the land is normally outside the boundary of a water and sanitation authority. The authorities therefore lacked the legal power to provide and recover the costs of services. Some examples of successful semi-legal arrangements made in Brazil are quoted. **International**

95-0516

**TQM in Orem, Utah: responsive agency, satisfied customers.**

B. W. CHESNUT (City of Orem, Utah), D. W. BUCKWALTER and R. J. PARSONS

*Journal of American Water Works Association* 1994, 86, No 10, 34-40

Mutual distrust and a lack of confidence in elected and appointed bureaucracy made it difficult to foster meaningful public participation. Total quality management (TQM) could improve communication and co-operation. An important TQM principle was customer focus. Some municipal governments had implemented TQM, reduc-

ing costs and improving effectiveness. Critical factors necessary for successful TQM were customer satisfaction, transformational leadership, shared vision, participatory relationships, substantive expertise and organizational culture. Prompted by water shortages, these factors were applied by the Water Resources Division of Orem, Utah to a planning and educational programme about water management and conservation. By encouraging the involvement of citizens in the planning process, the residents developed confidence in the programmes which were developed and were willing to conserve water. The city's employees learned how to better meet customer needs. **U.S.A.**

95-0517

**Policy on private water sales in rural Ghana.**

F. O. BOADIU (Texas A&M University, College Station, U.S.A.)

*Journal of Water Resources Planning and Management* 1994, 120, No 6, 944-961

Strategies for forming public-private sector partnerships to improve water distribution in rural regions of Ghana are examined. Some of the options being considered for the provision of potable water supplies and the maintenance of water facilities are discussed. Findings of a limited case study demonstrated a wide disparity between public and private prices of water and indicated a need for more rigorous pilot programmes and further studies on the viability of these partnerships. **Ghana**

95-0518

**Cooperative ground-water resources management: local perspective.**

A. A. PUCCI (Lafayette College, Easton, Pa.)

*Journal of Water Resources Planning and Management* 1994, 120, No 6, 984-991

The geohydrologic problems, social concerns and statutory authority issues involved in the regional management of groundwater resources are examined. A self-reliant approach to regional management developed by a consortium of 9 municipalities in the Delaware river valley, Bucks County, Pa., is described. Benefits of local cooperative management of regional groundwater resources include efficiency, advantages and long-term effectiveness. Implementation and maintenance of cooperative planning and action is discussed. **U.S.A.**

95-0519

**Putting a price on water in the Middle East.**

I. WALKER (Middle East Consultants, London, U.K.)

*Water & Wastewater International* 1994, 9, No 5, 14-15

The significance of water resources in international relationships is briefly discussed. The importance of water management is considered with reference to agriculture in Oman. Control of water pollution in Bahrain is outlined. **Middle East**

95-0520

**Borehole rehabilitation project helps Mursi control their destiny.**

L. A. EDWARDS (World Bank Group, Washington, D.C.)

**U.S.A.**

*Water & Wastewater International* 1994, 9, No 5, 16-17

A 40,000 U.S. dollar project to salvage 100 water sites in Kenya is outlined. Operational training in site management and engineering maintenance formed the basis of the project funded by the African Medical and Research Foundation. A small project team was set up

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to provide further guidance on maintenance problems and to engender trust of the local inhabitants. **Kenya**

### 95-0521

#### **Trial application of a geographic information system for the management of water bodies in the Department of Indre-et-Loire.**

G. CROSNIER (ENGREF, Montpellier)

*Bulletin de Liaison des Laboratoires des Ponts et Chaussées*

1994, No 192, 78-81 (in French)

A computerized mapping and information system was applied on a trial basis to the water management problems involving the Vienne river basin in the Indre-et-Loire département during the period April to October 1993. It involved the software package GLOCCONCEPT which was employed for identifying the position of all sites and inputs relevant to the monitoring of river quality together with details of natural features and flow characteristics, coupled with points of abstraction and other criteria affecting the river management process such as flooding and possible hazards from accidental pollution. The data were stored in files representing 66 different categories of information. The information could be presented visually in a variety of different scales depending on whether a local or basin wide situation was considered. The trial had enabled a user guide to the application of the system to be produced along with an indication of some potential problems to be resolved, such as the amount of manual work involved in the task of inputting all the relevant data. (English translation 180 pounds sterling, valid for 1995). **France**

### 95-0522

#### **Performance improvement: a challenge for water utilities.**

F. DUKLERHARDT (Ernst & Young LLP, New York) and G. L. KRAMER

*Journal of American Water Works Association*, 1994, **86**, No 10, 41-47

Fundamental concepts of performance improvement are introduced. Performance improvement was the systematic evaluation of processes to ensure that customers' expectations regarding cost, quality and timeliness were met in the most cost-effective manner. Changes could be fast or structured, strategic or tactical. The methodologies reviewed are focused improvement, continuous improvement, restructuring and process innovation/reengineering. Appropriate situations for their use and important elements for successful application are discussed. To be sustainable, performance measurement was needed, and changes had to have organizational and employee support. **U.S.A.**

### 95-0523

#### **The role of corporations in the management of the marine environment**

H. PICKERING (Portsmouth University)

*Marine Pollution Bulletin*, 1994, **28**, No 10, 629-637

Oil pollution incidents continue to occur despite legislation. The operational tasks of environmental management are implemented by employees of corporate organizations, who need have no knowledge of legislation, and whose activities depend on corporate management systems. Corporate environmental management systems could be improved by education concerning the true costs and benefits of operations and environmental responsibility, and accounting for the costs and benefits. There are 41 references. **U.K.**

### 95-0524

#### **Methodical approach to problem solving for a water management policy for the future.**

L. FLEISCHHACKER (Tiroler Wasserkraftwerke AG

Innsbruck)

*Wasserwirtschaft*, 1994, **84**, No 10, 544-548 (in German, English summary)

The problems of water resource management in the long-term are discussed and a forward-planning, self-stabilizing cybernetic model is proposed as a means of simulating the behaviour of the total water utilization spectrum, based on the concepts of systems engineering, logistics and project management, supported by the latest innovative data management procedures. The application of this concept is discussed with reference to the water supply situation in the Austrian Tyrol. The approach outlined by reference to the model is claimed to render it easier to allow for all the conflicting resource management objectives while taking account of the relevant legal and administrative constraints. (English translation 235 pounds sterling, valid for 1995). **Austria**

### 95-0525

#### **Privatization at a crossroads.**

W. A. PETERSON (Woodward & Curran Environmental Services, Wellesley, Mass.)

*Water Environment & Technology*, 1994, **6**, No 11, 56-60

Operational problems and a decrease in quality of service are identified as causes of a potential decline in the proportion of privately operated wastewater treatment facilities. Recent positive U.S. experience is briefly described and concerns about recent acquisitions, investment activity, increasing influence of foreign companies and increased competition are presented. Impacts of contract operations on staff are considered. Risk management and cost effectiveness are discussed. **U.S.A.**

### 95-0526

#### **Feasibility of point-nonpoint source trading for managing agricultural pollutant loadings to coastal waters**

S. R. CRUTCHFIELD (U.S. Department of Agriculture

Washington, D.C.) D. LITSON and A. S. MAUIK

*Water Resources Research*, 1994, **30**, No 10, 2825-2836

The trading of pollution abatement between point and non-point sources, which allow point sources to sponsor non-point source controls rather than install additional controls of their own, is considered in connection with agricultural pollutant loadings to coastal waters. This type of trading could allow water quality goals to be met at lower cost. Difficulties with incentive policies of this kind are identified. Coastal catchments were screened for conditions which would determine whether trading could improve water quality. This provided an initial empirical assessment of trading in the case of agricultural loadings to coastal waters. There are 47 references. **U.S.A.**

### 95-0527

#### **BOO to the golden goose.**

M. POROKHYSA

*Water Services*, 1994, **98**, No 1186, 30-32

The Scottish Office planned to encourage Build Own Operate (BOO) schemes with 545 million pounds sterling for 15 major water and sewerage projects. Regional Councils opposed the proposals which they considered as both an attempt to introduce privatization and as less cost-effective than the traditional loan funding method. **U.K.**

95-0528

**Sewers for monsieur.**

P. ALLISON

*World Water and Environmental Engineering* 1994, 17, No 9, 24 and 26

The complex structure of the French water industry is outlined. Overall co-ordination, planning and development was the responsibility of the Water Directorate within the Ministère de l'Environnement, which was also responsible for the 6 Water Agencies which oversaw implementation of water policy in the major river basins. French national water policy was based on the 1992-96 4 year plan. Most of the expenditure would be used to improve wastewater treatment and sewerage networks to comply with the EC Urban Wastewater Directive. In recent years, water prices had risen at a rate above the rate of inflation and water charges were expected to continue to increase. The Directive had also changed the industry's approach to sewage treatment which was no longer limited to organic pollution. Increasingly sophisticated treatment processes were being developed. **France**

95-0529

**Commercial and profitability aspects of groundwater utilization in view of the Water Laws.**

F. OBERLEITNER (Bundesministerium für Land- und Forstwirtschaft, Wien)

*Österr. Wasser- u. Wasserw. 1994, 48, No 10, 335-337 (in German)*

The difficulties of determining the real economic returns from the provision of water supplies in a market sector where the price was influenced both by political factors and the impact of the large and complex body of Austrian water legislation are reviewed. Pressure for increased utilization of groundwater resources posed serious problems concerning the hidden costs associated with their protection and possible lawsuits which could arise from unpredictable costs. The costs associated with the construction of abstraction and treatment facilities, together with the operation of the distribution network were readily ascertained, but in the face of growing pressures for conservation of natural resources and the degree of protection conferred by law on existing water users, landowners and the public enjoyment of natural resources, there was a likelihood that more intensive utilization of groundwater reserves might bring with it financial penalties and compensation awards which were not quantifiable in advance. (English translation 115 pounds sterling valid for 1995). **Austria**

95-0530

**The abstraction charge for water in Lower Saxony and its operation**

G. MEYER (Niedersächsisches Umweltministerium, Hannover) and A. MONIZ

*Österr. Wasser- u. Wasserw. 1994, 48, No 10, 585-589 (in German, English summary)*

The provincial government for Lower Saxony, having enacted an eighth amendment to the Lower Saxony Water Law, was empowered to levy a charge for the abstraction of water from either surface or groundwater sources. The purpose of this charge was to make funds available for the conservation and protection of water resources. The size of the charge was based on the nature of the source, the volume abstracted and the intended use. Certain exemptions were allowed as in the case of desirable ecological uses, while public service undertakings were also entitled to discounts which might be as high as 75 per cent. For waterworks a flat rate of 0.10 DM per m<sup>3</sup> was charged. The scale of charges and the expected annual revenue are considered

and the manner in which the money was to be applied in the interests of water management and water quality protection is discussed. It could be used, for example, to prevent excessive inputs of nitrogen originating from agriculture and forestry activities of an intensive nature. (English translation 180 pounds sterling valid for 1995).

**Germany**

95-0531

**Economic review: development of the public water supply for the German Federal Republic during the first half of 1994.**

G.W.F. Wasser/Abwasser 1994, 135, No 10, 601-604 (in German)

Statistics regarding the level of drinking water production from a representative group of German water undertakings during the first half of 1994 are presented. Data for supply and consumption broken down into various classes of use are tabulated together with a summary of meteorological data for the same period, giving monthly temperature and rainfall averages compared with data for the same period in 1993. Some additional figures relating to peak consumption are included and movements in the producer prices for water both for domestic and industrial uses are also reported, depending on the consumption related tariff band. (English translation 110 pounds sterling valid for 1995). **Germany**

95-0532

**Developing rates with citizen involvement**

R. REED (David M. Griffith & Associates, Carmichael, Calif.) and R. L. JOHNSON

*Journal of American Water Works Association* 1994, 86, No 10, 48-60

A comprehensive water rate study was carried out in 1992 by the Marin Municipal Water District in response to customer dissatisfaction with increasing water rates during the drought of 1986-92. A citizen advisory committee was appointed. The resulting water rate structure was based on marginal cost pricing and had wide public support. It complemented the district's water management programmes which emphasized water conservation and which were also developed with the advisory committee's assistance. **U.S.A.**

95-0533

**Water affordability and alternatives to service disconnection**

J. A. BLECHER (Ohio State University, Columbus)

*Journal of American Water Works Association* 1994, 86, No 10, 61-72

The issue of water affordability primarily concerned low income residential customers. Problems included increased arrears, late payments, disconnections and service terminations which also affected utilities in terms of the expenses associated with credit collection and disconnection activities. Utilities preferred assistance oriented programmes in co-operation with social agencies over rate structure modifications. Alternatives to disconnection included counselling and referral, community assistance, monthly billing, arrears forgiveness, payment discounts, income based payments, lifeline rates, targeted conservation, disconnection moratoria and flow restriction. Some of these methods lowered water use, others lowered utility charges. Many utilities combined several alternatives in their programmes. There are 31 references. **U.S.A.**

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95-0534

### Privatization promises.

R. A. J. ARTHUR

*Water & Waste Treatment* 1994, 37, No 11, 42-45

The issue of whether the ordinary water customer has had a fair deal from water privatization is examined. The government had argued that privatization would benefit customers by increasing efficiency and enabling the water industry to fund environmental costs without excessively increasing costs to the home consumer. In practice, domestic customers were partly paying for the cleanup costs of industry and agriculture. U.K.

95-0535

### Integrated water management: the NRA's confident message.

*Water News* 1994, No 56, 5-7

The role and functions of the National Rivers Authority (NRA) in integrated water management as presented in its annual report and summary are discussed. The achievements of the NRA since its establishment in 1989 are summarized, particularly in the areas of river and canal water quality, bathing water quality, pollution control, water resources, relations with the users of the water environment, policy making and environmental matters, and NRA management. Expenditure and income are also outlined. Future objectives are discussed. U.K.

95-0536

### The pricing of water in a university town: an economic analysis of draining a cash cow.

B. P. JOYCE (Michigan Technological University, Houghton) and T. T. MERZ

*Water Resources Research* 1994, 30, No 10, 2807-2811

Economic issues associated with the common policy of raising the metered water rate in a community in order to use water rate revenue to fund debt retirement connected with the provision of municipal water and wastewater services are examined. The advisability of raising the tax rate levied under its local property tax rather than raising the metered water rate was considered. An increased property tax rate could result in tax savings for some home owners, resulting in a reduction in their net expenditure for water, while lowering the metered rate might increase water consumption, raising operating costs. Reasons for not treating customers like universities with a low price elasticity of demand for water as a cash cow are given. U.S.A.

95-0537

### Benefit transfer protocol for long-term health risk valuation: a case of surface water contamination.

S. B. KASK (Western Carolina University, Cullowhee, N.C.) and J. E. SHOGREN

*Water Resources Research* 1994, 30, No 10, 2813-2823

Recent discussion by economists of the desirability of using the concept of benefit transfer as a cost-effective method in valuation studies in conditions of scarcity of financial resources is reviewed. Most consideration had focused on recreational benefits, but it was necessary to direct attention to another key benefit from improved water quality: the reduction in risk to public health. A protocol for benefit transfer of long-term health risk reduction was developed. A case study concerning contamination of surface water was also conducted. Aspects considered included the multiple sources of risk, the latency period between cause and effect, and the ability of an individual to reduce the severity of the risk. There are 33 references. U.S.A.

95-0538

### The cost of rural water supply: a case study in South Africa.

M. A. SCHUR

*Water SA* 1994, 20, No 3, 179-186

A brief history of water supply development in South Africa since the 1970s is given, focusing on the institutional constraints. No single agency was responsible for ensuring that all households were served with adequate water supply and sanitation. The institution framework was fragmented and uncoordinated. Nongovernmental organizations (NGOs) operating in the water sector more recently, favoured small-scale schemes, with an emphasis placed on community participation in village water supply developments. A detailed cost analysis of a rural water project is given. The Matefe water project was initiated by the Rural Advice Centre, an NGO, to provide safe primary and secondary water supplies to all the people of Matefe, and, in particular, removing asbestos and harmful bacteria from the water. The community provided all the unskilled labour with the residents responsible for digging trenches and laying pipes. The project's costs did not compare favourably with World Health Organization estimates for rural water supply schemes. However, the estimates were based on extrapolations of existing data and the cost of the Matefe scheme did not differ significantly from the actual costs of projects in other sub-Saharan African countries. South Africa

95-0539

### Tariff systems for industrial wastewater discharges.

P. E. SØRENSEN (Kruger Consult AS, Søborg, Denmark) and E. G. CALVO

*Water Science & Technology* 1994, 29, No 9, 11-19

Charges for industrial discharges in Denmark and France are explained and compared. In the former, fees are levied for the initial connection; a regular charge is made for effluent based on metered consumption and, in principle but rarely in practice, a surcharge was added according to the toxic constituents. The French system is more complicated. The River Basin Agencies charge for all discharges on the basis of the pollution load on an average day using 9 quality parameters. The accumulated funds were used for administration, research and subsidies for the construction and operation of treatment plants. It encourages the production of high quality effluent.

An improved tariff system is proposed which draws on the best features of both. Details of the tariff systems are provided.

Europe

95-0540

### Privatization: businesses ask what was the point?

J. MANSON

*Water Services* 1994, 98, No 1186, 48-49

National Utility Services, a utility charges specialist, could see little sign of any gains for the customer from water industry privatization. Capital investment was still funded by high customer charges. Water companies did not have the same competitive pressures as other utilities. A national water grid would be the first step in opening up the water industry to competition. U.K.

95-0541

### The impact of forest harvesting on water yield: modelling hydrological changes detected by pollen analysis.

R. E. WILBY (Derby University, U.K.) and P. A. GILL

*Hydrological Sciences Journal* 1994, 39, No 5, 471-486

Hydrological changes brought about by forest harvesting practices were investigated in the Delegate river basin of south eastern Australia using palynological techniques. Three short cores taken in the

upper basin showed the onset of a very marked change in the representation of one of 2 aquatic taxa synchronous with the beginning of forest harvesting activities in the areas. The hydrological impact appeared to be akin to that of regeneration following a bushfire. The changes were explained by applying a 2 parameter exponential bushfire yield trend model to the wet eucalypt forests above the pollen core site. A 50 per cent reduction in water yield was predicted to occur by the year 2005. The ecological and hydrological impacts are considered. **Australia**

95-0542

#### Impacts of spatially and temporally varying snowmelt on subsurface flow in a mountainous watershed: 1. Snowmelt simulation

C. N. FIERCHINGER (USDA Agricultural Research Service, Boise, Idaho), K. R. COOLEY, and Y. DING

*Water Resources Research*, 1994, **30**, No 5, 507-520

Spatially varying snowmelt and groundwater response in a small mountainous catchment was simulated. Snowmelt recharge through the snow-groundwater systems was the principal source of streamflow in many catchments of this type. The SHAW (Simultaneous Heat and Water) model, a detailed process model describing the interaction of heat and solute movement through vegetative cover, snow, residue, and soil, was used to simulate snowmelt. The model was validated by applying it to 2 years of data at sites with conditions ranging from shallow transient snow cover on a west-facing slope to deep snow drift on a north-facing slope. Energy balances were calculated for several melt periods. (See also following abstract)

U.S.A.

95-0543

#### Impacts of spatially and temporally varying snowmelt on subsurface flow in a mountainous watershed: 2. Subsurface processes

C. FIERCHINGER (Idaho University, Boise), C. N. FIERCHINGER, and K. R. COOLEY

*Water Resources Research*, 1994, **30**, No 5, 521-533

Field measurements and numerical simulations were used to evaluate the impacts of spatial and temporal variations of snowmelt recharge on subsurface flow in a small mountainous catchment. The hillslope infiltration and subsurface flow mechanisms were characterized using a fully saturated flow model, VAM2D. Results concerning preferential snowmelt along a hillslope transect from the computer simulations were used as input for analyses of subsurface flow. Depending on the extent of snowmelt recharge, the hillslope aquifer was affected by hydrogeological conditions for confined and unconfined groundwater flow. The VAM2D model was able to simulate preferential flow patterns reasonably closely. (See also preceding abstract)

U.S.A.

95-0544

#### Forecasting the hydrological consequences of global climatic changes.

A. H. SCHUMANN (Universität Bochum, Germany)

*Water Resources*, 1994, **84**, No 10, 550-555 (in German, English summary)

The attempts which have been made to forecast the regional and catchment-related impacts of global climatic variations on the hydrological processes and rainfall-runoff relationships in these areas are outlined. The uncertainties inherent in the methods employed for rainfall prediction, such as the use of global circulation models, are discussed, followed by a consideration of the changes in the influ-

ence of vegetative cover on the runoff generated in response to the predicted rainfall. These vegetation-induced effects, in response to global warming, comprise longer annual growth periods and hence greater transportation times, changes in the relative composition of plant communities, increased efficiency of water utilization by practically all plant species, increased stomatal resistance and diminished stomatal densities, and larger leaf surfaces for transpiration and respiration, in response to elevated carbon dioxide levels in the atmosphere. Factors such as these compound the problem of determining the runoff yield from a given catchment and thus further accentuate the possible uncertainties in the forecasting process. (English translation 205 pounds sterling, valid to 1995)

International

95-0545

#### Data-based mechanistic modelling and the rainfall-flow non-linearity

P. C. YOUNG (Lancaster University) and K. J. BEVEN

*Environmental Modelling*, 1994, **5**, No 3, 335-365

The nature of the nonlinear processes involved in the relationship between rainfall and river flow is considered. The data-based mechanistic (DBM) approach to model structure identification and parameter estimation for linear and nonlinear dynamic systems was used to explore the nonlinear relation between measured rainfall and flow in 2 typical catchments. The time-series data yielded nonlinear transfer function models of the rainfall-flow dynamics through the use of recursive estimation. The DBM modelling approach provided a useful tool for the investigation of rainfall-flow processes and other linear and nonlinear environmental systems. There are 44 references.

U.K.

95-0546

#### Representation of spatial variability of rainfall in aggregated rainfall-runoff models

P. BARTOLINI (Genova University) and E. B. VALEDES

*Journal of Hydrological Engineering*, 1994, **120**, No 10, 1199-1219

Analysis of the relationship between distributed and aggregated linear rainfall-runoff models confirmed that the use of average rainfall as aggregated input could yield poor reproduction of observed discharges. After deriving aggregated inputs defined as the solution of the inverse problem for a set of storm events in a given basin, linkages detected between mean areal precipitation, point precipitation and the derived aggregated input were represented by a weighting function which varied during the storm and enabled determination of the aggregated input from single rain gauge models. Application of a linear distributed model coupled with rainfall field generated by a stochastic space-time precipitation model to a north-east Italian catchment indicated that derivation of the weighting function would require a large number of controlled experiments. Preliminary results are presented for a single distributed rainfall field generated by the simpler stationary single cell version of the Waymire, Gupta and Rodriguez-Iturbe stochastic precipitation model. **Italy**

95-0547

#### Precipitation distribution in coastal British Columbia

A. LOUKAS (British Columbia University, Vancouver) and M. C. QUICK

*Water Resources Bulletin*, 1994, **30**, No 4, 705-727

The areal distribution and the areal and temporal variation of the monthly, seasonal and annual rainfall in 2 mountainous catchments in the south-west of British Columbia were analysed using a detailed

data set from the period 1971 to 1990. Rainfall increased in both catchments up to an elevation of around 400 m, in each case roughly at the middle of the catchment, and then levelled off in one and decreased in the other. Rainfall for the lower valleys and their adjacent slopes was similar. The temporal variation in rainfall was least at the mid point of the catchments; this variation was greatest in summer and least in autumn and winter. Spatial variation in rainfall was generally small; in all cases the correlation coefficient was greater than 0.65 for distances less than 32 km. The results of this study were similar to 2 other analyses for the coastal north west Pacific area and the findings suggested that the rainfall distribution results could be applied more generally to that area. **Canada**

**95-0548**

## Evaluation of cluster-based rectangular pulses point process models for rainfall.

J. VIEGHE (Ghent University), P. A. TROCH, E. P. de TROCH and J. VAN DE VIJDE

*Water Resources Research*, 1994, **30**, No 10, 2847-2857

Cluster-based point rainfall models were compared using hourly rainfall data from Denver, Colo., for the period 1949-1976. Three classes of model: the Bartlett-Lewis model, the geometric Neyman-Scott model, and the Poisson-Neyman-Scott model, were compared both with respect to the original formulation of the structure of each model and in the case of the modified description developed to improve the zero depth probability. The geometric-Neyman-Scott model gave better results than the Poisson-Neyman-Scott model. In addition, the Bartlett-Lewis model was very sensitive to the sets of moment equations used in parameter estimation, while no such sensitivity was seen with the Neyman-Scott model. **Belgium**

**95-0549**

## From data and theory to environmental model: the case of rainfall runoff.

A. J. TAJEMAN (Australian National University, Canberra), A. C. T. D. A. POST and M. B. BECK

*Environmetrics*, 1994, **5**, No 3, 297-314

Ways of developing models of environmental systems are considered. Most models developed to simulate the effects of changing input parameters were based either on idealized equations of mathematical physics, such as those of fluid flow and transport, or on compartmentalized conceptual descriptions of processes. Both approaches often suffered from over-parameterization. An alternative approach, which began with simple assumptions and built up the level of model detail by testing additions and refinements to the model structure, was developed. This approach, described as system identification, was applied to the case of rainfall-runoff modelling. There are 32 references. **Australia**

**95-0550**

## Climatic variability of soil water in the American Midwest: part I. Hydrologic modelling

D. H. BAI (U.S. Department of Agriculture, Pendleton, Ore.) and K. P. GEORGAKAKOS

*Journal of Hydrology*, 1994, **162**, No 3/4, 355-377

Hydrological processes in large basins of the U.S. upper Mississippi region were simulated using a conceptual rainfall-runoff model based on the U.S. National Weather Service hydrological model. The model was used to estimate daily streamflow from daily rainfall, temperature and potential evapotranspiration data for 3 adjacent headwater basins in the region. Issues associated with parameter estimation, the reliability and stability of parameter estimates and the

interpretation of soil water estimates were explored. The model was suitable for estimating the variability of aggregate soil water across large areas of the Midwest provided all significant inflows and outflows were accounted for (see also following abstract). **U.S.A.**

**95-0551**

## Climatic variability of soil water in the American Midwest: part 2. Spatio-temporal analysis.

K. P. GEORGAKAKOS (Hydrologic Research Center, San Diego, Calif.) and D. H. BAI

*Journal of Hydrology*, 1994, **162**, No 3/4, 379-390

Aggregated estimates of soil water for 3 large basins in the U.S. Midwest produced using a conceptual rainfall-runoff model based on the U.S. National Weather Service hydrological model are considered. The soil water estimates were consistent with the atmospheric forcing of daily precipitation, potential evapotranspiration and air temperature, and with the observed daily streamflow divergence during a 40-year period. Temporal and spatial features of the variability of estimated soil water content were identified. Estimates for the 3 study basins showed strong similarities in annual cycles and in interannual variability (see also preceding abstract). **U.S.A.**

**95-0552**

## The extreme behaviour of the runoff yield from snowmelt and rainfall: first results.

H. MATTHIAS, S. M. RACHNER and G. SCHNEIDER

*Korrespondenz-Abwasser*, 1994, **41**, No 10, 1762-1764 (in German, English summary)

The effects of snow cover in modifying the rainfall-runoff relationship in a mountain catchment during the winter months are discussed. The snow layer intercepted the rainfall with the result that runoff might be delayed for long periods, possibly until the spring when the volume of snowmelt was increased, and a much higher runoff yield would be obtained. The resulting extreme values for runoff could have serious consequences in terms of flash floods and peak flows in the drainage system. A range of data concerning extreme runoff events, together with rainfall data for catchments in the Potsdam and Kempten, were examined to evaluate the runoff response and to estimate return periods for flows of a certain magnitude. (English translation 100 pounds sterling valid for 1995). **Germany**

**95-0553**

## Effect of rainfall-sampling errors on simulations of desert flash floods

J. D. MICHAUD (Arizona University, Tucson) and S. SOROKOSHIAN

*Water Resources Research*, 1994, **30**, No 10, 2765-2775

The effect of rainfall-sampling errors on rainfall-runoff simulations is considered, with particular reference to conditions not studied by previous researchers, namely localized thunderstorms occurring above a 150 km<sup>2</sup> semi-arid catchment. Rainfall-sampling errors were highly significant in this setting, as was shown by sampling observed rainfall fields in different ways and using the results as inputs to a distributed rainfall-runoff model. This approach was made possible by the availability of data from an extremely dense rain gauge network at the Walnut Gulch experimental basin, Ariz. Spatial resolutions of measurement networks to achieve reliable simulations are considered. There are 33 references. **U.S.A.**

95-0554

**Modelling infiltration during complex rainfall sequences.**

C. CORRADINI (Perugia University), F. MELONE and R. F. SMITH

*Water Resources Research*, 1994, 30, No 10, 2777-2784

A conceptual model previously developed to describe point infiltration during a storm consisting of 2 parts separated by a runoff hiatus with surface saturation and runoff occurring in both parts, was extended to describe a wider variety of real situations. The extension was designed to include the representation of a sequence of infiltration redistribution cycles with situations not leading to soil surface saturation and rainfall periods with an intensity lower than the soil infiltration capacity. The extended model was tested by comparison with numerical solutions of Richards' equation for various experiments on 2 different soils. The model results were very accurate. Italy

95-0555

**Modelling water infiltration in unsaturated porous media by interacting lattice gas-cellular automata.**

J.-B. D'ELIÈRE (Institut National de la Recherche Agronomique, Avignon-Montfavet), A. MELAYAH and S. ZALESKI

*Water Resources Research*, 1994, 30, No 10, 2785-2792

Saturated and unsaturated water infiltration in porous media was simulated using a 2-dimensional lattice gas-cellular automaton fluid model with long range interactions. Applications of the dense and high phases of the cellular automaton fluid were used to simulate water and gas within the porous medium, respectively. Various wetting properties were modelled by adjusting the corresponding fluid-fluid interactions. The lattice gas rules included a gravity force to allow for buoyancy driven flow. The model was able to simulate flow regimes with established macroscopic approaches (capillary, such as those obeying Poiseuille's law). There are 33 references. France

95-0556

**Real time flood forecasting using a stochastic rainfall generator.**

F. FARDET (Newcastle University) and C. OBLID

*Journal of Hydrology*, 1994, 162, No 3/4, 391-408

Methods of extending the lead time of flood forecasts on small catchments (up to 1000 km<sup>2</sup>) when using a lumped rainfall runoff model and data with a time step of about 1 h are considered. It was assumed that meteorological forecasting was not feasible at such short time steps and at small spatial scales. A stochastic rainfall model which generated future rainfall conditioned by present observed data was developed. The proposed method was applied to the Gardon d'Anduze catchment (545 km<sup>2</sup>) in the Mediterranean region of the Cevennes. Output was reliable up to 4 h ahead, but could be useful for decision making beyond this period. U.K.

95-0557

**Assessing the joint probability of fluvial and tidal floods in the river Roding.**

M. V. ACREMAN (Institute of Hydrology, Wallingford)

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 5, 490-496

An historical reconstruction method of joint probability analysis was developed for estimating estuary water of a specified return period in the Roding river. This was an alternative to assessing over bank inundation by numerical integration of the marginal probability distribution of river floods and sea levels; this was complex mathe-

matically and demanded explicit knowledge of the correlation structure. The proposed method required a time series of flows in the river, a concurrent time series of levels in the Thames, a hydraulic model to produce water levels, and a statistical model to analyse the frequencies. The model was one-dimensional and used the St Venant flow equations. A generalized extreme value distribution was fitted by the method of probability weighted moments. Although the estimation of extreme events relied on large extrapolations of data it produced satisfactory results for flood risk assessment. U.K.

95-0558

**Relationships between *n*-day flood volumes for infrequent large floods.**

J. B. BALDICK (U.S. Army Corps Engineers, Walla Walla, Wash.) and S. J. BURGES

*Journal of Water Resources Planning and Management*, 1994, 120, No 6, 794-818

The construction of a design flood hydrograph is discussed. A design flood hydrograph for high return periods (*d* and *n*-day flood volumes) was constructed using measured flood flow volume-duration frequency data. This approach was applied to flood flow data from 7 Pacific north west river catchments (Methow, Willapa, Grays, Nehalem, Siletz, Umpqua and White Salmon rivers). The applicability of the nested (concurrent) requirement to these catchments was evaluated. There was no apparent link between catchment physical and climatological features and flood volume concurrence or coincidence of frequency. A general method for constructing design flood hydrographs for low exceedance probabilities (high return periods) is given. U.S.A.

95-0559

**Reliability of flood warning systems.**

R. KRZYSZTOFOWICZ (Virginia University, Charlottesville), K. S. KELLY and D. LONG

*Journal of Water Resources Planning and Management*, 1994, 120, No 6, 906-926

A methodology is presented which could form the basis for the reliability analysis of a local flood warning system. Performance measures based on a Bayesian theory are described and numerical procedures for computing these measures are developed. Two case studies of flood warning systems in Pennsylvania are reported: Milton on the Susquehanna river and Connellyville on the Youghiogheny River. Tradeoffs between the reliability and the lead time of warnings are examined. U.S.A.

95-0560

**Deterministic modelling of the extreme flood for a mountain catchment with application of the geomorphological description to the hydrographic network.**

V. LAGI AINI (Ecole polytechnique fédération de Lausanne), D. BEROD, D. DEVRÉD and A. MUSY

*Revue des Sciences de l'Eau*, 1994, 7, No 3, 285-308 (in French, English summary)

Previous methods of flood prediction based on probable maximal precipitation with the aid of a transfer function in which the relevant runoff parameters were maximized, proved inadequate for mountainous alpine catchments owing to their steep slopes, poor vegetation and thin soil cover, resulting in very fast responses to storm events. To take these factors into account, a geomorphological description of the catchment was devised as a starting point. This was constructed using the Strahler ordering scheme for defining the customary paths for surface runoff and provided the basis for



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formulating the geomorphologic unit hydrograph (GUH) which was combined with additional data for exceptional paths to produce the geomorphologic nonlinear cascade (GNC) model. These 2 models (GUH and GNC) were calibrated using an optimization process and tested on the Vogelbach catchment in the Swiss Alps. This catchment (only 1.5 km<sup>2</sup> in area) gave good agreement for both models although the GUH model tended to smooth the discharge. Further refinements to the modelling process were being evaluated. There are 34 references. (English translation 440 pounds sterling valid for 1995). **Switzerland**

### 95-0561

#### **Western water resources - the desert is blooming, but will it continue?**

J. E. PLUMMER (Calvert County Department of Planning and Zoning, Prince Frederick, Md., U.S.A.)

*Water Resources Bulletin*, 1994, **30**, No 4, 595-603

A review was presented of historical and present day water resource development in the Colorado catchment located in the arid and south western U.S.A. Development of water resources this century enabled increased migration to the warm and sunny climate, giving rise to an increasing water demand that had utilized all available sources of water. Attention is given to the problems thus created, and the increasingly significant role that water management would have in the future. The water management options recently adopted by Arizona are described. **U.S.A.**

### 95-0562

#### **Predicting temporal and spatial flood dynamics using a pre-calibrated model**

M. A. HUSTON (Oak Ridge National Laboratory, Tenn.) and J. A. FONTAINE

*Water Resources Bulletin*, 1994, **30**, No 4, 651-661

A hydrologic model (TOPMODEL) which had been calibrated previously for the west fork of Walker branch watershed, Tenn. was evaluated for its flood prediction capability subsequent to a storm in December 1990. TOPMODEL was a semi distributed hydrologic model that predicted overland flow, saturated water and soil water, making use of a topological index which could be derived from topological maps. The maximal extent of overland storm flow was deduced from leaf litter transport from valley bottoms. The model which had been calibrated for a 3 month period of normal flow events in 1986, accurately predicted overland flow and flood hydrograph for the 1990 storm event. **U.S.A.**

### 95-0563

#### **Flood damage estimation - a review of urban stage-damage curves and loss functions**

D. E. SMITH (Australian National University, Canberra)

*Water SA*, 1994, **20**, No 3, 231-238

Stage damage curves were essential to flood damage assessments. The development of the concept of stage damage curves is considered, in particular, the use of existing databases and valuation surveys to obtain synthetic stage damage curves. Problems in the construction of synthetic or actual damage stage damage curves were classified as: what to include; what values should be allocated to items; how many building types should be used; scatter and error; and interpolation and extrapolation. Synthetic techniques were preferred. Ratios of actual to potential damage were important to give the best estimate of actual loss. Critical combinations of depth and velocity could cause the structural failure of building and such information should be incorporated into flood damage studies. Guidelines are

presented for the use of stage-damage curves for residential and commercial buildings in South Africa. **South Africa**

### 95-0564

#### **Equivalent steady soil moisture profile and the time compression approximation in water balance modelling**

G. D. SAI VUCCI (Massachusetts Institute of Technology, Cambridge) and D. ENTEKHABI

*Water Resources Research*, 1994, **30**, No 10, 2737-2749

Two fundamental components of water balance modelling, the pre-event soil moisture profile and time compression analysis, were subjected to detailed analysis. Numerical integration of the governing equations for liquid moisture flow in the unsaturated zone was used in simulations designed to show the role of temporal variability in the system. The equivalent steady state moisture profile yielded an adequate estimate of the temporal mean, mean pre storm and mean post storm moisture profiles. The time compression approximation provided an adequate description of the nonlinear state-dependent transition of surface flux from climate to soil control. There are 42 references. **U.S.A.**

### 95-0565

#### **A two-parameter monthly water balance model for French watersheds**

Z. MAKHLOUT (CEMAGREF, Antony) and C. MICHEL

*Journal of Hydrology*, 1994, **162**, No 3/4, 299-318

The performance of lumped monthly water balance models used for water resources assessment and management is considered. Because of the severe time lumping involved, these models could not be physically based and were at best conceptual or empirical. For this reason they were generally simple, with very few parameters to be calibrated. A new water balance model was developed with only 2 parameters to be calibrated or estimated using physical characteristics for use on a given catchment. In spite of its lack of sophistication, the model generated results which compared favourably with those of other widely used monthly water balance models. **France**

### 95-0566

#### **Experiments using a long-time-scale shelf circulation model of relevance to the Labrador Current**

R. J. GREATBATCH (Newfoundland Memorial University, St. John's), B. K. PAI and Y. REN

*Continental Shelf Research*, 1994, **15**, No 1, 41-57

A 3 dimensional shelf circulation model relevant to the southward flowing Labrador Current was used in a series of numerical experiments. The model included a rectangle in latitude longitude space with a shelf slope region bordering the northern and western boundaries and a deep ocean region in the south east. Relatively light water was flushed in through the northern boundary and allowed to exit through the southern boundary. Bottom friction was parallel to bottom velocity, leading to a relatively diffuse downstream jet. The results obtained contributed to an enhanced understanding of the long term behaviour of the Labrador Current. **Canada**

### 95-0567

#### **Estuarine barrages and their influence on groundwater**

F. W. HLOYD (Birmingham University)

*Journal of Hydrology*, 1994, **162**, No 3/4, 247-265

The implications for groundwater hydrology of proposals to construct several low crested barrage embankments across estuaries in the U.K. are examined. Modifications of the hydrological regime to

facilitate infrastructural projects were likely to raise the groundwater head, resulting in dampness in properties in urban areas. The hydrogeological complexity of many of the urban estuaries for which barrages were proposed together with the small expected rise in groundwater heads made head rise predictions based on deterministic numerical modelling unreliable. A programme of staged implementation with comprehensive monitoring of head rise is proposed to minimize adverse impacts. U.K.

95-0568

**Wave-induced longshore current in surf zone.**

D. YOO (Ajou University, Suwon)

*Journal of Waterway, Port, Coastal, and Ocean Engineering*, 1994, 120, No 6, 557-575

A numerical model of longshore currents generated by irregular waves in the surf zone was developed. The wave field was defined from wave number vector equations and an energy conservation equation with superposition procedure was applied to the description of irregular waves. The current field was defined using a continuity equation and momentum conservation equations. Attention was given to the effects of bed friction on a movable bed and mixing processes arising from shear flow dispersion and turbulence. The performance of the model was compared with a previous analysis of longshore waves on a uniform beach using the same field data. There are 2 references. Korea

95-0569

**Satellite observations of wave heights in Arabian sea and Bay of Bengal.**

C. SATHESAN (Anna University, Madras) and S. P. SUBRAMANIAN

*Journal of Waterway, Port, Coastal, and Ocean Engineering*, 1994, 120, No 6, 576-579

Wave data recorded by the GEOSAT altimeter between November 1986 and October 1987 were used to derive wave heights in the Arabian sea and the Bay of Bengal. Monthly wave height distributions indicated that waves were highest during the south west monsoons. The north east monsoon waves were higher than those observed outside the monsoon season. The maximal wave height observed were 5 m for the Arabian sea and 4 m for the Bay of Bengal. India

95-0570

**Buoyancy forced interaction between estuary and inner shelf: observation.**

K. C. WONG (Delaware University, Newark) and A. M. SCHOW

*Continental Shelf Research*, 1994, 15, No 1, 59-88

The hydrographic variability of the Delaware estuary and the adjacent inner continental shelf of the Mid-Atlantic Bight were examined in May and June 1990, using shipboard instruments including an acoustic Doppler current profiler. Significant 2-dimensional density variability was found in the estuary and on the adjacent shelf. Weak vertical stratification with strong transverse variability occurred within the estuary, while denser water concentrated in the centre of the estuary. Two branches of lighter water were observed near both shores. Buoyant estuarine water formed a southward flowing down-slope coastal current on the shelf. There are 45 references. U.S.A.

95-0571

**Low-cost remote-sensing techniques applied to drainage area studies.**

A. SCOTT (Scott Wilson Kirkpatrick, Basingstoke)

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 5, 497-501

Colour and infra-red video images of sub-catchments were obtained from helicopter-mounted cameras to assess percentage permeability. The data were digitized, the infra-red image modified to match the colour image, then the computer was programmed to recognize impermeable areas by manually identifying them in a small part of the sub-catchment and using this information for calibration. Impermeability for input to the WATERLUS model of the sewerage system was estimated from the pixel areas. Flow predictions were acceptable. The method gave a detailed and up-to-date record of the study area compared with Ordnance Survey information. The results were sufficiently encouraging to justify hardware improvements and computer techniques. U.K.

95-0572

**Classification of river corridors: issues to be addressed in developing an operational methodology.**

A. M. GIBNELLE (Southampton University, P. ANGLAND) and K. T. GREGORY

*Aquatic Conservation*, 1994, 4, No 3, 219-231

A classification scheme for river corridors that would have wide application for assessment or management needs to have a hierarchical structure and to incorporate different types of data from a range of sources is described. Spatial units for handling data must be defined, and be applied before data are integrated. Data handling should maintain a separation between raw data and derivatives, and use a spatial resolution which was appropriate for the hierarchical level to which it applied. U.K.

95-0573

**Some river wavelets.**

D. R. BRILLINGER (California University, Berkeley, U.S.A.)

*Environmetrics*, 1994, 5, No 3, 211-220

Methods for the estimation of mean functions of time series models are considered. The simplicity of Haar wavelet analysis in producing an estimate of a mean function is emphasized. The methodology paralleled the common techniques for running means and kernel smoothers. A Haar wavelet analysis was carried out for time series data on the flow rate of the Nile river at Aswan and on the stock of the Rio Negro at Manaus. The particular case of wavelets and the construction of supposedly improved estimates by shrinkage are considered. The wavelet method had important application to environmental time series analysis. There are 4 references. International

95-0574

**Environmental significance of ice to streamflow in cold regions.**

T. D. PROWSE (Environment Canada, Saskatoon, Sask.)

*Freshwater Biology*, 1994, 32, No 2, 241-259

Cold region environments are classified into 5 distinct hydrological regimes based on source and timing of runoff: proglacial, wetland, spring fed, Arctic tundra and subarctic, river. Representative hydrographs of these hydrological regimes are described. The source and pathways of streamflow in cold regions are reviewed: snow cover, permafrost and groundwater. Ice jams. The channel effects of floating ice are described with reference to ice formation processes.

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freeze up processes, stable ice cover formation, unique habitats, radiation regime, oxygen exchange, mixing processes and sediment transport, and break up processes. Future research areas are identified. There are 95 references. **Canada**

95-0575

**Time-series modelling for long-range stream-flow forecasting.** M. BENDER (Manitoba University, Winnipeg) and S. SIMONOVIC

*Journal of Water Resources Planning and Management*, 1994, 120, No 6, 857-870

Existing methods for long-range water supply forecasting are compared with statistical time-series tools such as seasonal autoregressive integrated moving average (SARIMA) modelling. Context-sensitive model selection was applied to the information contained in data sets for forecasting monthly water supply. Models were developed and applied to 3 types of river basin data within a sensitivity analysis of flow scenarios. Ranking of model performance for possible system scenarios suggested a set of rules to govern the choice of a single model to produce the best available forecast. The modelling tools were used to evaluate the performance of long-range monthly probability stream flow forecasts at Manitoba Hydro, a large utility that operated a multireservoir electric power generation system. **Canada**

95-0576

**The flood and sediment characteristics of the Lower Yellow river in China**

J. W. SOONG (Illinois State Water Survey, Champaign, Ill, U.S.A.) and Y. ZHAO

*Water International*, 1994, 19, No 3, 129-137

Rapid economic development and population growth along the Lower Yellow river region in China emphasized the urgent need for flood control and reducing flood disasters. Flooding solutions for this river were closely related to its sedimentation problems. The erosion/deposition patterns are examined and related to flood and sediment characteristics along the river. Rules for erosion/deposition under different floods are discussed together with aggradation/degradation patterns over the last decades. Operations of the Sanmenxia reservoir, which controlled about 92 per cent of the total drainage area of the basin, are discussed. The impact of human activities on the flow and sediment regimes in the river are also examined. Present and proposed measures for harnessing the floods are discussed. **China**

95-0577

**The Southern Oscillation index as a predictor of the probability of low streamflows in New Zealand**

M. T. MOSS (National Institute of Water and Atmospheric Research, Christchurch), C. P. PEARSON, and A. I. MCKIRCHAR

*Water Resources Research*, 1994, 30, No 10, 2717-2723

The relationship between the Southern Oscillation index (SOI), a standardized measure of the concurrent differences in sea level atmospheric pressures at Darwin, Australia, and Tahiti, and subsequent streamflows on the South Island of New Zealand was investigated. The feasibility of forecasting the probability that seasonal streamflows would be less than a critical amount as a function of the previous season's SOI was examined. Bayesian probabilities were used to define the uncertainties in the forecasts attributable to the number of lagged parts of data for the streamflows and the index

values. There was significant information transfer between the 2 time series. **New Zealand**

95-0578

**Covariance properties of Great Lakes annual net basin supplies.**

S. G. BUCHBERGER (Cincinnati University, Ohio)

*Water Resources Research*, 1994, 30, No 10, 2725-2735

The covariance properties of Great Lakes annual net basin supplies (serviced quantities used to account for all processes by which water enters or leaves the lakes) were examined for the case of supplies estimated as the residual term in a lake water balance. The cross-correlation function and auto correlation function for annual net basin supplies were derived on the assumption that annual lake outflows and water levels were autoregressive lag 1 processes and that each lake behaved as a linear reservoir. The study showed that the residual method currently used to estimate net basin supplies could induce an artificial long tail in the autocorrelation function. The implications for attempts to simulate Great Lakes water levels are considered. **U.S.A.**

95-0579

**The perfect reservoir.**

W. HOWIE

*New Civil Engineer*, 1994, No 1104, Water Supplement, 15-16

A brief account of the construction of the Thirlmere reservoir and aqueduct by Manchester Corporation in the later 19th century is given. By 1875, the city's supply from Longendale had become inadequate for the demands of the cotton industry, on which the city's economy depended, and for supplying the households to which the Waterworks Committee had decided that a supply should be made available. Furthermore, the water's quality was inadequate for cotton bleaching and dyeing, the unfinished cloth having to be sent to Glasgow. The original plan for a supplementary source was to tap Ullswater, but Thirlmere was selected (then 2 smaller lakes joined by a stream). The purchase of the parcels of land forming the catchment area is described, and the passage of relevant enabling legislation through Parliament in 1879 is sketched. A decline in the cotton industry relieved the necessity for immediate take-up of the scheme's authorization, work on the aqueduct beginning in 1885 and on Thirlmere dam in 1890. The work was completed 2 years behind schedule in 1894. **U.K.**

95-0580

**Management of recharge dams in Saudi Arabia**

F. F. AL-MUTTAIR (King Saud University, Riyadh), I. SENDIL, and A. S. AL-TURBAK

*Journal of Water Resources Planning and Management*, 1994, 120, No 6, 749-763

The efficiency of recharge dams was examined using specified alternative management plans at 2 recharge dams, Malham and Al-Amalih, located north of Riyadh. The Malham dam was a 100 ft long, 5 m high rockfill dam constructed in 1970 while the Al-Amalih dam was a 500 m long, 8 m high concrete dam constructed in 1982. The management plans included the present management system, release of reservoir water to the downstream channel, release to a downstream basin, removal of silt from the reservoir bed and scratching of the reservoir bed. Because of the topographical changes and the seasonal flood times and sizes, the results of field studies were not easily comparable. Recharge efficiencies were evaluated and compared by simulations. Recharge efficiency was improved by silt removal and scratching of the reservoir bed. **Saudi Arabia**

95-0581

**'Artificial respiration' for lakes and reservoirs.**

C. RAMEL (ITT Flygt)

 *Eau Industrielle Nuisances*, 1994, No 176, 78-82 (in French; English summary)

The quality of large bodies of water was often seriously impaired by the input of nutrients and organic matter from non-point sources, and this is reflected in a decline in the level of dissolved oxygen to critical levels allied with a tendency for eutrophication. To counteract this effect and to raise the level of dissolved oxygen throughout the water column, special equipment for promoting vertical mixing and re-aeration was developed. This involved the use of a submersible vertical flow pump with a screw-type impeller, which would be used either to force oxygen-rich water from the epilimnion downwards to mix with the bottom water in the hypolimnion, or to drive the bottom water upwards, with a similar result. The results of tests with both methods are presented followed by an account of a trial performed on the Kleiner Uckersee at Plön, Germany. Oxygen transfer and temperature balances for the lake waters are reported, from which the energy requirement to achieve the required degree of transport of oxygen from the epilimnion to the hypolimnion could be calculated. The output of the submersible pump was 8.75 m<sup>3</sup> per hr and more than 200 kg of dissolved oxygen was transferred for an energy consumption of 50 kWh. (English translation 135 pounds sterling valid for 1995). **France**

95-0582

**Protective functions of vegetative filter strips alongside water-courses in hilly districts.**

M. BAU, H. Justus Liebig Universität Gießen, J. E. ABIS, and H. C. FRIEDL

*Wasserwirtschaft*, 1994, 84, No 10, 524-527 (in German; English summary)

Installation of vegetative filter strips alongside rivers has been regarded as a means of curtailing the entry of pollutants into the river by reason of their filtering action with respect to both soluble and soluble constituents present in surface runoff, especially after heavy rain and snowmelt periods. In addition similar benefits result from the reduction on protecting the watercourse from direct inputs of fertilizers and pesticides applied close to the bank, and from wind-blown airborne drift where there is a shelter belt of trees or tall shrubs on one side of the strip. Some of these functions are of doubtful benefit in hilly districts where they ground slopes steeply down to the stream. A survey carried out in a hilly district in southern Germany enabled a trial length of 41.4 km of filter strips (composed of 4600 sections) to be identified in a catchment area of 12.9 km<sup>2</sup>. Despite their apparent benefits, it was concluded that they were largely unsuccessful in contributing to a reduction in the input of nitrogen, phosphorus and pesticides to the adjoining stream for a variety of reasons. In many cases they were not wide enough, a minimum width of 3 m is advocated, while in others there was insufficient vegetative cover to provide a proper screen against windborne contaminants, or surface runoff. Adequate materials retention from runoff only occurred when the strips are level and have a width of at least 5 m. (English translation 170 pounds sterling valid for 1995). **Germany**

95-0583

**Lateral thinking solves stratification problems.**

R. L. SPLECH (Vanderbilt University, Nashville, Tenn.)

*Water Quality International*, 1994, No 3, 12-15

A method of oxygenating the hypolimnion of a water body without upsetting its natural stratification is described. The desirability of maintaining cold, but well oxygenated, water close to the bottom is outlined. Trout fisheries are improved, the release of phosphorus from algal detritus in sediments back to the epilimnion is avoided, and iron, manganese, and hydrogen sulphide problems that could arise to a water abstractor if the water was anoxic, are averted. The problem is to prevent the injected oxygen bubbles rising at such a velocity as to induce de-stratification while still allowing adequate time for oxygen uptake by the water. In the method described, oxygen is injected at the tip of a cone through which water also enters; in their downward passage, the cross-sectional area of the cone increases so that the downward velocity decreases to the point where it is less than the buoyant velocity of the bubbles; these become trapped, thereby allowing time for oxygen uptake by the water. Concentrations of 10-150 mg oxygen per litre are obtained. The oxygenated water is then pumped by horizontal pipes, fitted with exit ports, into the hypolimnion at a port velocity of 3.6 cm per second. Case histories are cited to indicate that a considerable longitudinal oxygenation occurs, and that the technique does not de-stratify even shallow (5 m) hypolimnions. **U.S.A.**

95-0584

**Water management consequences of the rebuilding programme for the Potsdamer Platz in Berlin.**

M. BOHME (Oberste Wasserbehörde, Berlin)

*GW-Wasser Abwasser*, 1994, 135, No 10, 565-568 and 570-572 (in German; English summary)

The very high water table which characterizes the area of the Potsdamer Platz would have a pronounced effect on the reconstruction programme, which was designed to restore the area to its former magnificence, now that the city of Berlin has been unified. Massive groundwater abstraction is precluded on account of the probable damage to the vegetation in the Tiergarten park and also the likely threat of subsidence and damage to the foundations of older buildings. Several alternative approaches to the problem of site dewatering are discussed, and any proposal must be subjected to an evaluation of their probable environmental and ecological consequences. In addition, the presence of previously unrecorded refuse tips could not be excluded, so that the groundwater might need to be subjected to chemical rehabilitation before discharge to a receiving water body. Whatever method was adopted it must allow the maintenance of a minimal groundwater level, and the progress of dewatering operations and any related side effect, must be carefully monitored. (English translation 240 pounds sterling valid for 1995).

**Germany**

95-0585

**The unit response of groundwater outflow from a hillslope.**

W. BRUTSAERT (Cornell University, Ithaca, N.Y.)

*Water Resources Research*, 1994, 30, No 10, 2759-2763

The linear version of the Boussinesq equation was used to describe surface flow from a hillslope. Solution of this equation was useful in making explicit some of the essential characteristics of this type of flow. Arbitrary input could be accommodated by simple convolution of the sudden drawdown problem. A simple dimensionless parameter could be used to determine the relative magnitudes of the driving mechanisms, specifically the streamwise pressure gradient

## WATER RESOURCES AND SUPPLIES

resulting in diffusion, and gravity, resulting in advection. The solution presented was potentially useful in assessing several approximate approaches to the problem proposed by earlier researchers (U.S.A.).

**95-0586**

### **Optimum operation of recharge basins.**

H. MUŠTAQ (Arizona State University, Tempe) and W. MAYS and K. E. LANSLEY

*Journal of Water Resources Planning and Management*, 1994,

**120**, No. 6, 927-943

A series of mathematical models, based on non-linear programming, was developed for determining the optimal operations of recharge basin systems. The models determined the operation policy (loading schedules) that maximized the infiltration volume subject to constraints for continuity, infiltration, groundwater flow, and the physical constraints of the basins. Modelling of the infiltration process and the soil moisture redistribution process is described. Several hypothetical applications are presented to illustrate the modelling procedure (U.S.A.).

**95-0587**

### **Bioremediation of chlorophenol contaminated ground water.**

K. E. JÄRVINEN (Lampere University of Technology) and T. A. PUHAKKA

*Environmental Technology*, 1994, **15**, No. 9, 823-832

The clean up of groundwater contaminated with chlorophenol using aerobic laboratory scale continuous flow fluidized bed reactors was investigated. Water samples were collected from the Karkola aquifer in Finland. Reactor performance was monitored at room temperature and at 10°C. The effects of different hydraulic retention times (0.75-5 h) were studied. The biomass in both reactors was enriched using synthetic chlorophenol feed. Chlorophenol degradation was monitored by inorganic chlorine release (ICl), organic carbon removal and GC analyses. Groundwater from the Karkola aquifer contained 44-55 mg per litre with 2,3,4,6-tetrachlorophenol as the principal congener. The groundwater chlorophenol and organic carbon concentration did not change significantly during 1992-1993 but ICl concentration decreased. More than 99 per cent biodegradation of chlorophenols was achievable at 10°C and 5 h hydraulic retention time. A decrease in temperature from 25-30°C to 10°C did not affect ICl release. The 99 per cent chlorophenol degradation was maintained even at 45 minutes hydraulic retention time (Finland).

**95-0588**

### **Drainage from roads and airfields to soakaways: groundwater pollutant or valuable recharge?**

M. PRICE (Reading University)

*Journal of Institution of Water and Environmental Management*,

1994, **8**, No. 8, 468-479

The construction of roads and airport runways creates surface water which is frequently drained into oil interceptors followed by soakaways. This is a potential source of groundwater pollution, particularly from leaking or significant accidents. An example of a conservative tracer travelling 3 km from a soakaway to a borehole in 10-33 d indicated that contamination was possible. In this case, the concentration of tracer at the borehole was extremely low. There were no clearly demonstrated examples of public groundwater supplies significantly polluted by highway drainage even when a known pollutant spill had entered an infiltration drainage system. Little is known about the fate of pollutants in sub-surface waters. Drainage from impermeable surfaces could be a significant source of aquifer

recharge. It would be prudent to minimize the risks to groundwater from highways by improved vehicle design which minimized leakage after accidents (U.K.).

**95-0589**

### **Making sure the risk exists.**

A. K. PACE (Malcolm Pirnie, Inc., Newport News, Va.)

*Water Environment & Technology*, 1994, **6**, No. 10, 34-38

Risk assessments were commonly used to set cleanup goals at contaminated sites, but they could also reveal when remediation was not necessary. Tetra chloroethene contamination of surface soils, groundwater and surface water in a drainage canal was traced to a shopping centre in Hampton, Va. A correction plant was recommended but a review of existing geologic and hydrogeologic data suggested that the remediation system would not be effective. A potential health-based risk assessment was recommended. Site characteristics were defined to determine the hydrogeologic parameters which would affect contaminant fate and transport. The risk assessment identified possible migration routes, exposure pathways and receptors for exposure to residual chlorinated solvent contamination. Remedial action was not considered necessary when no federal, state or local groundwater standards were exceeded, site contaminant were degrading over time, and continued groundwater monitoring would ensure that concentrations did not exceed standards or guidelines (U.S.A.).

**95-0590**

### **Optimal capacity-expansion planning in multiaquifer systems.**

H. BASAGÖĞÜL (Middle East Technical University, Ankara) and H. YAZICIOĞU

*Journal of Water Resources Planning and Management*, 1994,

**120**, No. 6, 836-856

The concept of optimal capacity expansion planning is discussed and extended to multiaquifer systems. Three different capacity expansion 0-1 mixed integer programming models were developed and evaluated for a hypothetical multiaquifer system. The response of the system was included in the models using response matrices. Model performances were compared in terms of computational requirements and approximation to pumpage costs under 3 water demand schedules. Trade-off curves relating pumpage to drawdown were also developed. Sensitivities of the models' results to variations in demand requirements, interest rates, and system parameters were studied (Turkey).

**95-0591**

### **Adaptive forecasting of hourly municipal water consumption.**

C. HOMWONGS (Texas A&M University, College Station), T. SASTRI and J. W. FOSTER

*Journal of Water Resources Planning and Management*, 1994,

**120**, No. 6, 888-905

Advantages and limitations of existing forecasting methods for hourly municipal water use are overviewed. An adaptive smoothing filtering approach is presented for on-line forecasting of hourly municipal water use time series. The methodology was based on Winters' exponential smoothing, recursive least squares and the Kalman filter. Implementation of this algorithm at the city of Arlington, Tex., is discussed. This method was suitable for forecasting in hourly water consumption time series that was influenced by changing weather conditions and measurement outliers. The proposed model was robust and could capture both weekday and weekend cycles to produce accurate forecasts from 1 to 24 h ahead (U.S.A.).

95-0592

**Effectiveness of water-conservation measures in greater Athens area.**

H. BRIASSOULIS (National Centre for Scientific Research Athens)

*Journal of Water Resources Planning and Management*, 1994, 120, No 6, 764-777

Recent studies evaluating the effectiveness of water conservation measures are overviewed and factors influencing model selection are discussed. The application of the autoregressive-integrated moving average (ARIMA) time-series modelling framework to water conservation measures initiated in the greater Athens area in Greece in May 1990 to overcome predicted water shortages is described. The model included 2 components: the first forecasted historical water consumption and the second accounted for the potential effects of conservation. Model estimation results are discussed. Both total charged and residential monthly water consumption dropped significantly after the initiation of the measures. Greece

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See also Abstracts 95-0526, 95-0666, 95-0691, 95-0726, 95-0755, 95-0756, 95-0957, 95-0961, 95-0985, 95-0993

95-0593

**Measuring and modelling chlorine propagation in water distribution systems.**

R. M. CLARK (U.S. EPA Cincinnati, Ohio), W. M. GRAYMAN, C. A. GOODRICH, R. A. DEINIGER, and K. SKOV

*Journal of Water Resources Planning and Management*, 1994, 120, No 6, 871-887

The application of the dynamic water quality model (DWQ24) developed by the U.S. EPA to the propagation of chlorine residuals in a water distribution system is described. Modelled and measured propagation at selected monitoring sites in Cheshire, Conn., are presented. The impact of system operation and design on compliance with the Safe Drinking Water Act and amendments and public health is discussed. Results of a verification study at the Cherry Hill Brushy Plains service are presented. Present and future research is also described, including the development of EPANET, state-of-the-art hydraulic water quality model. The study findings indicated that a simple first-order decay model associated with modelling chlorine residuals was inadequate. U.S.A.

95-0594

**Some reflections on the use of models in hydrology.**

G. B. MARSILLY (Universite Paris VI)

*Revue des Sciences de l'Eau*, 1994, 7, No 3, 219-234 (in French, English summary)

This article contains a philosophical analysis of the nature of the mathematical models employed for studying the migration of contaminants (pesticides etc.) in groundwater systems. It classifies the models into 2 types: namely those constructed from actual measurements on the system concerned, and those for which there were no observable data in existence and were based entirely on the supposed physical mechanisms at work. The modelling technique based on observed phenomena is likened to a black box, in which the motor might have a number of forms, but its nature must be inferred from the available data. Certain constraints were essential to limit indis-

criminate application or extrapolation of such models, which are stated by analogy with the classical Greek tragedy, as unity of place, unity of time and unity of action. The significance of these criteria is discussed. Regarding the development of models for which no observable data exist, certain fundamental requirements are outlined, such as prior identification of the real geometry, analysis and representation of the underlying physical processes, and an analysis of possible scenarios which take into account all probable changes in the boundary conditions. There are 34 references. (English translation 455 pounds sterling, valid for 1995). France

95-0595

**Estimating the probability of exceeding groundwater quality standards.**

D. P. ABLETT (Connecticut University, Storrs) and M. S. ISLAM

*Water Resources Bulletin*, 1994, 30, No 4, 623-629

A simple transport model provided the basis of a model designed to estimate the probability of exceeding groundwater standards at specific locations in areas where limited information on hydrogeological site conditions was available. Using Monte Carlo simulations, the effects of uncertainty in hydraulic conductivity had on contaminant uncertainty were established. The response of each parameter exceeded a probability to the variation of the various parameters in the model is presented graphically for a generic example. The topology of the exceedence probability surface could be used to assess the effect of individual parameter variation. U.S.A.

95-0596

**Nutrient and metal accumulation in a freshwater tidal marsh.**

H. KHAN (The Johns Hopkins University, Baltimore, Md.) and G. S. BRUSH

*Estuaries*, 1994, 17, No 3, 345-360

Fossil pollen and seeds of indicator high and low marsh plants were used to trace the development of a freshwater tidal marsh on the Patuxent river in the coastal plain of Maryland. The accumulation of nutrients and trace metals over time was determined. Analysis showed that the high marsh was formed only within the past 100 years following an increase in sedimentation rates in the area. Variations in accumulation between the high and low marshes over several decades showed that pollutants from agricultural runoff and wastewater discharge were stored in high marsh sediments more than in low marsh sediments, probably because of the higher organic carbon level in the former. There are 59 references. U.S.A.

95-0597

**A benthic index of environmental condition of Gulf of Mexico estuaries.**

A. D. ENO (Technical Resource, Inc., Gulf Breeze, Fla.) and K. SUMMERS, and G. R. GASTON

*Estuaries*, 1994, 17, No 2, 372-384

A statistical benthic index of estuarine environmental condition was developed for the estuaries of the Gulf of Mexico, based on extensive data on benthic community structure. Test sites were identified as degraded or undegraded on the basis of criteria for dissolved oxygen levels, sediment toxicity tests and sediment contamination. Stepwise and canonical discriminant analysis were used to select and test a subset of parameters which described the benthic community structure and discriminated between types of habitat. Spatial patterns of degraded benthic resources in the Gulf of Mexico were evaluated using the resulting index. There are 47 references. U.S.A.

## WATER QUALITY

95-0598

**The effects of livestock grazing on western riparian and stream ecosystem.**

C. AKMOUR (U.S. National Biological Survey, Fort Collins, Colo.), D. DUFF, and W. ELMORE.  
*Fisheries*, 1994, 19, No 9, 9-12

This article is the culmination of several years of review and discussion at Division and parent levels of the American Fisheries Society. The policy statement addresses problems caused by overgrazing and action items that the Society advocates to be implemented to correct problems. The Society does not advocate ceasing of domestic livestock grazing on public lands but suggests that grazing is acceptable providing its management is compatible with the ecological requirements of healthy riparian and stream ecosystems. U.S.A.

95-0599

**Ecology of alpine, glacial, high latitude and mountain streams: introduction and synthesis.**

M. J. WINTERBOURN (Canterbury University, Christchurch)  
*Freshwater Biology*, 1994, 32, No 2, 235-239

This paper is an introduction to a special issue on the ecology of alpine, glacial, high latitude and mountain streams. Eleven of the 16 papers in the special issue were presented at the North American Benthological Society Annual Meeting in Calgary, Canada in May 1993. The papers are reviewed. They fall into 3 categories: (1) review and discussion papers that consider broad physical and ecological aspects of alpine, high latitude and glacial streams; (2) regional studies emphasizing distributional patterns; (3) experimental studies concerned with ecosystem processes. The studies relate to streams in Alaska, Nepal, New Zealand, Switzerland, and southern Africa. **International**

95-0600

**Ecology of alpine streams.**

J. V. WARD (Colorado State University, Fort Collins, U.S.A.)  
*Freshwater Biology*, 1994, 32, No 2, 277-294

Ecological conditions and zoobenthic communities of kryal, krenal and rhithral streams of the alpine zone are described and compared. Kryal streams are fed by glacial meltwater and are characterized by low temperatures and large diel flow fluctuations in summer. Biota include diamesine chironomids. Fish and higher plants are absent. Rhithral segments are characterized by soft water, an extended period of snowmelt runoff and a broader temperature range than kryal or krenal biotypes. Biota consists of bryophytes, macroalgae, epiphytic and epilithic diatoms, insects, turbellarians, acari, nematodes, and nematodes. Krenal streams are fed by groundwater and are typically calcareous with constant flow regimes. The biota includes bryophytes, macroalgae, diatoms, fish, and chironomids. Longitudinal distribution patterns of the 3 types of streams are described. Biogeographic patterns exhibited by the benthic fauna of the high altitude streams are examined. There are 84 references. **International**

95-0601

**Glacial rivers: physical habitat and ecology.**

A. M. MILNER (Alaska University, Anchorage, U.S.A.) and G. L. PETTS  
*Freshwater Biology*, 1994, 32, No 2, 295-307

The physical characteristics (flow, temperature, water quality, morphological characteristics, channel processes) of glacial rivers are considered. The biota of glacial rivers are described and the effects of temperature, turbidity, discharge, sediment transport and channel

form on the benthic communities of glacial rivers are outlined. Longitudinal and temporal faunal gradients in glacial streams are reviewed. A qualitative model of invertebrate community structure in glacial rivers is presented which incorporates the effects of temperature and channel form and stability. The effects of climatic change on glacial distribution are discussed. There are 60 references. **International**

95-0602

**Altitudinal trends in the diatoms, bryophytes, macroinvertebrates and fish of a Nepalese river system.**

S. J. ORMEROD (Wales University College of Cardiff, U.K.), S. D. RUNDLE, S. M. WILKINSON, G. P. DALY, K. M. DALE, and I. JUTTNER

*Freshwater Biology*, 1994, 32, No 2, 309-322

Hydrobiological changes were assessed along an altitudinal transect of tributaries from 600-3750 m in the Likhu Khola and Langtang catchments in Nepal. Physico-chemistry, diatoms, bryophytes, macroinvertebrates and fish were studied. Macrophyte, bryophyte and diatom data were analysed by detrended correspondence analysis (DECORANA) and TWINSpan. Increased taxon richness occurred with declining altitude. Diatoms characteristic of lower altitude streams were mostly motile, epipelic or episammic. There were no significant patterns of bryophyte cover or taxon richness among catchment types. At least 6 fish species were caught in the Likhu Khola but none were caught in the Langtang streams. There are 32 references. **Nepal**

95-0603

**Macroinvertebrate communities of streams in western Nepal: effects of altitude and land use.**

A. M. SUREN (NIWA Ecosystems, Christchurch, New Zealand)  
*Freshwater Biology*, 1994, 32, No 2, 323-336

The influence of altitude and land use on macroinvertebrate communities were studied in 43 streams in the Dolpo region of western Nepal in 1992. Site altitude was 850-4250 m. Land use types were alpine, forest, grassland, pasture and agricultural land. Environmental and invertebrate data was analysed using TWINSpan and DECORANA. The streams were classified using TWINSpan into 4 groups on the basis of semi-quantitative physico-chemical data. A total of 138 macroinvertebrate taxa were collected from 53 insect families. Ephemeroptera (37.8 per cent) were the most common, followed by Trichoptera (30.9 per cent). Taxonomic richness decreased with increasing altitude. Ten families were more abundant at lower altitudes (below 2000 m) and 3 families were more abundant in higher streams. Altitude, temperature, stream width and land use were implicated in structuring invertebrate communities. There are 44 references. **Nepal**

95-0604

**Macroinvertebrate community structure and altitudinal changes in the upper reaches of a warm temperate southern African river.**

C. PALMER (Rhodes University, Grahamstown), A. PALMER, J. OKEFFE, and R. PALMER

*Freshwater Biology*, 1994, 32, No 2, 337-347

Changes in the macroinvertebrate community in the first 30 km (elevation change of 780 m) of the Buffalo river, South Africa, were investigated. The river has relatively low altitude headwaters and is a warm temperate stream. The river was sampled monthly at 4 sites monthly in 1987. Flow at the headwater site was seasonal and the site was characterized by low conductivity, pH and nutrient concen-

trations. The riffle community at the headwater site was the most distinct site. Twelve taxa were found only at this site. Flow at the foothill site was perennial and the site was characterized by higher conductivity, pH and nutrient concentrations. The invertebrate community at this site lacked the unique taxa of the headwater site. The rate of elevation change paralleled the pattern of changes in the riffle-dwelling macrobenthos of the upper Buffalo river. There are 56 references. **South Africa**

#### 95-0605

##### **Influence of water abstraction on the macroinvertebrate community gradient within a glacial stream system: La Borgne d'Arolla, Valais, Switzerland.**

G. I. PETTS (Birmingham University, U.K.) and M. A. BICKERTON

*Freshwater Biology*, 1994, 32, No 2, 375-386

The macroinvertebrate gradient within La Borgne d'Arolla, a glacial stream impacted by the Grand Dixence hydropower scheme, Switzerland, was investigated. Thirty-eight sites were surveyed in July 1993 along a 9 km reach downstream of the Upper Arolla glacier. Data were analysed by TWINSpan and detrended correspondence analysis (DCA). The glacial streams contained only Chironomidae (*Diamesa*). There were no fauna in the streams 200-500 m below the glacier snouts. Immediately below the water intakes the streams were intermittent and were devoid of fauna for up to 1.5 km. Abstraction of glacial meltwater increased the importance of snowmelt and groundwater downstream, with an increase in water temperature and water clarity. Downstream of the intake, stable sites had a relatively rich fauna including Baetidae, Plecoptera, Trichoptera, Chironomidae, Simuliidae and Diptera. Twenty-four taxa were found in the tributary streams, including 6 which were not found in the principal river. DCA showed that distance from source and altitude were the dominant environmental variables. Channel width was also significantly correlated with tributary data. The impact of water abstraction was to isolate the glacial melt from the river downstream and to convert the river below the intakes to a warmer, clearer and more stable channel. **Switzerland**

#### 95-0606

##### **Colonization and succession of invertebrate communities in a new stream in Glacier Bay National Park, Alaska.**

A. M. MILLNER (Alaska University, Anchorage)

*Freshwater Biology*, 1994, 32, No 2, 387-400

Changes in the benthic community of Wolf Point Creek, a young stream in Glacier Bay, Alaska, were investigated in 1978-1990. Physico-chemistry, macroinvertebrates, and fish were studied. Macroinvertebrate data were analysed with TWINSpan and DECORANA. Invertebrates, particularly Chironomidae, showed site-specific temporal succession. Maximal species richness occurred in 1988. Total invertebrate density was greatest in 1978. Water temperature was the most significant factor determining the year of colonization of invertebrate taxa. Dolly Varden were the first salmonids to colonize the stream. There are 55 references. **U.S.A.**

#### 95-0607

##### **Wetland and stream buffer size requirements - a review**

A. J. CASTELLE (Adolfson Associates, Seattle, Wash.), A. W. JOHNSON, and C. CONOLLY

*Journal of Environmental Quality*, 1994, 23, No 5, 878-882

Buffers (undisturbed vegetation) could be used to reduce or eliminate the impacts from adjacent land uses on aquatic resources. The effectiveness of a buffer was determined by its size. Four criteria

identified for determining adequate buffer sizes for aquatic resources: resource functional value, intensity of adjacent land use, buffer characteristics, and specific buffer functions required. A literature search suggested that a scientific approach to determining buffer size would depend on the specific functions that a buffer needed to provide under site-specific conditions. Buffer functions and the buffer widths necessary to achieve these functions are reviewed: sediment removal and erosion control, excess nutrient and metal removal, moderation of stormwater runoff, moderation of water temperature, maintenance of habitat diversity, wildlife species distribution and diversity, and reduction of human impact. Criteria considered by U.S. regulatory agencies in determining buffer sizes are discussed. There are 39 references. **U.S.A.**

#### 95-0608

##### **From wastelands to wetlands.**

W. H. PATRICK (Louisiana State University, Baton Rouge)

*Journal of Environmental Quality*, 1994, 23, No 5, 892-896

The beneficial value of wetlands has only recently been recognized. Definitions of wetlands are discussed. A wetland should have 4 components: water, unique soils that differed from adjacent uplands, and vegetation adapted to the wet conditions. The effects of excess water on soils and plants are reviewed. The presence of excess water meant that the plants did not suffer from moisture stress, the entry of atmospheric oxygen into the soil was restricted, and decomposition of dead plants was slow. Major wetlands found in the U.S.A. include coastal salt marshes, tidal freshwater marshes, mangrove swamps, riparian wetlands, swamps, peatlands, and inland freshwater marshes. The destruction of wetlands, the beneficial functions of wetlands, and wetland protection in the U.S.A. are discussed. **U.S.A.**

#### 95-0609

##### **Riparian wetlands and water quality**

L. W. GILHAM (North Carolina State University, Raleigh)

*Journal of Environmental Quality*, 1994, 23, No 5, 896-900

Riparian buffers are frequently present between small streams and farming and urban activities on the uplands. Nonpoint pollution removal by riparian buffer is reviewed with respect to sediment removal, nitrate removal from subsurface water, phosphorus removal, and removal of pesticides and faecal bacteria. The importance of these riparian buffers for maintaining water quality is emphasized. It is argued that development of wetlands on the interstream divides would have less of a detrimental effect on water quality than development of any other soils in North Carolina. There are 31 references. **U.S.A.**

#### 95-0610

##### **Ecological responses of an oligotrophic floodplain forest to harvesting**

B. G. LOCKABY (Auburn University, Ala.), L. C. THORNTON, R. H. JONES, and R. G. CLAWSON

*Journal of Environmental Quality*, 1994, 23, No 5, 901-906

The effects of clearcut harvesting on water quality and hydrology in blackwater forest systems in Alabama, U.S.A., were investigated. The sites were narrow floodplains of low order blackwater streams and were dominated by phosphate deficient histosols and a mixed deciduous evergreen forest. Two harvesting techniques were used: minimal intensity (handfelling plus helicopter extraction of logs) and maximal intensity (a feller buncher on mats combined with skidder log removal). Harvesting had no significant effect on nitrate or phosphate levels or BOD in water samples. Nitrate and phosphate



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levels were quite low. Denitrification exhibited a strong seasonal trend and considerable within site variation (7-20 kg per ha year). There was a short-term reduction in the water table depth at harvested sites. This was attributed to an evaporation response to elevated soil temperatures. U.S.A.

95-0611

### **The impact of a riparian wetland on streamwater quality in a recently afforested upland catchment.**

B. A. EMMETT (Wales University, Bangor), J. A. HUDSON, P. A. COWARD and B. REYNOLDS

*Journal of Hydrology*, 1994, **162**, No. 3/4, 337-353

The possible role of wetlands in mitigating the impact of land use practices is considered in the case of a small remnant wetland situated at the outflow of an afforested catchment in mid Wales. Studies during a 2 year period in the Ceuant Ddu catchment showed that the wetland was effective in reducing the volume weighted concentrations of a number of solutes. The streamwater dissolved nitrogen loading was reduced by 38 per cent. Reductions in phosphate (94 per cent), total dissolved phosphorus (42 per cent), total monomeric aluminium (39 per cent), total filterable aluminium (21 per cent), iron (54 per cent) and dissolved organic carbon (34 per cent) were observed. U.K.

95-0612

### **Consequences of the reduction of saline pollution in the Werra and the Weser, with reference to the watercourses as ecosystems.**

J. BATHE (Niedersächsisches Landesamt für Ökologie, Hildesheim), V. HIRSH, G. HOLMANN, U. MATTHIES and R. THIEL

*Wasserwirtschaft*, 1994, **84**, No. 10, 528-535 (in German, English summary)

Severe changes occurred in the aquatic biocoenoses of the Werra and the Weser during the 1950s and 1960s as a result of the discharge of saline waste waters from the potassium mineral extraction plants in Thuringia and Hessen. The decline in fish populations and the loss of almost all native species of plankton and lower organisms forming the diet of freshwater fish aroused such widespread concern that discussions were initiated between the provincial authorities, the water management and pollution control organizations and the industrial producers. These resulted in an agreement to bring about a phased reduction in the saline inputs to the water bodies. To monitor the effectiveness of these reductions, a network of sampling and monitoring stations was established on the Werra, Fulda, Weser and Aller rivers, together with numerous tributaries. Regular examinations of the chloride content of the water and of the composition of the benthic fauna have been carried out at these points since March 1993 to ascertain the extent to which the native aquatic communities had recovered. The results for 1993 are presented and confirm the decreasing trends in salinity accompanied by the gradual re-establishment of a natural freshwater biocoenoses. There are 30 references. (English translation 190 pounds sterling valid for 1995)

Germany

95-0613

### **Landscaping plans for the Wuppertal reservoir - an assessment from an ecological viewpoint.**

R. MONIG

*Wasserwirtschaft*, 1994, **84**, No. 10, 538-542 (in German, English summary)

The construction of a major reservoir in the middle reaches of the Wupper river during 1987 resulted in far-reaching changes to the landscape and the animal and insect communities of the affected area. Prior to the impounding of the Wupper, extensive surveys were performed of local fauna and flora from which comprehensive lists of native species were prepared. The principal features of the area before and after flooding the reservoir basin are described, and the effects of various landscaping and nature conservation measures are examined in the light of changes that had occurred in the 6 years since their implementation. The effects of the forebays, including the necessity for heavy traffic to haul away the large amount of accumulated sediment, are considered, and also the success of various measures such as the provision of artificial breeding sites for a number of bird species is discussed. While many of these were capable of fulfilling their intended purpose, the proximity of other facilities, such as campsite and caravan parks, tended to limit their effectiveness and in future much larger areas should be set aside as refuges for endangered species, during the planning of the scheme. (English translation 205 pounds sterling valid for 1995)

Germany

95-0614

### **Indicator bacteria and limnological parameters in fish ponds.**

R. MARKOSOVA (Charles University, Prague) and J. JEZEK

*Water Research*, 1994, **28**, No. 12, 2477-2485

Indicator bacteria, temperature, dissolved oxygen, BOD and chlorophyll *a* were measured over 6 years in 3 eutrophic ponds of average depth 1.5 m and 50 ha area. The ponds were managed by introducing young *Cyprinus carpio* in spring and harvesting them in autumn of the second year. Populations of indicator bacteria increased with water temperature, maximal number occurring in summer. The fish affected bacterial numbers and the other parameters. During the second years of fish stocking, when biomass was high, indicator bacteria numbers, BOD and phytoplankton were greater but the numbers of large daphnids were depressed. If pond water quality had to be optimized, planned fish yields would have to be reduced.

Czech Republic

95-0615

### **Role of weather and water quality in population dynamics of submersed macrophytes in the tidal Potomac river.**

V. CARTER (U.S. Geological Survey, Reston, Va.) and B.

RYBICKI, J. M. LANDWEHR and M. TURTORA

*Estuaries*, 1994, **17**, No. 2, 417-426

Interrelations among water quality, weather and fluctuations in populations of submersed macrophytes were examined between 1983 and 1989 in 2 reaches of the tidal Potomac river. The hypothesis that the areal coverage of submersed aquatic vegetation in the tidal river was controlled by light availability, a function of weather and water quality, was investigated. Changes in mean seasonal Secchi depth were related to changes in seasonal total suspended solids and chlorophyll *a* concentration. Secchi depth was highly correlated with plant growth in the upper tidal river and chlorophyll *a* and total suspended solids with plant growth in the lower tidal river. There are 36 references. U.S.A.

95-0616

**Two eutrophic models make the grade.**

M. R. ERNST (Tarrant County Water Control and Improvement District Number One, Fort Worth, Tex.), W. FROSSARD and J. L. MANCINI

*Water Environment & Technology*, 1994, 6, No 11, 15-16.  
The U.S. EPA Water Analysis Simulation Program (WASP4) and the U.S. Army Corps of Engineers BATHUB eutrophication model for water supply, recreation and flood control reservoir management are briefly described. The WASP4 program was used by Tarrant County at 2 of its 4 reservoirs, the BATHUB program at 3 and both were used for the Cedar Creek reservoir in a comparative study of the effectiveness of the models. Characteristics of both are tabulated. Both were valuable for evaluating reservoir impacts and enhancements; the BATHUB model was preferred for initial and internal screenings and for assessments where data were limited. The WASP4 program was suitable for regulatory action and final management decision making. U.S.A.

95-0617

**Benthic ecology of a spring-fed river of interior Alaska**

J. D. LAPIERRE (Alaska University Fairbanks)

*Freshwater Biology*, 1994, 32, No 2

Clearwater creek is a spring-fed stream in Alaska. The physical and chemical characteristics of the stream were studied in 1977-1979. The water temperature ranged from 0 to 7.8°C, although the air temperature range was 35°C. A steady flow was maintained. The water was dominated by calcium and bicarbonate ions. Conductivity, alkalinity and hardness varied little during the year but all 3 decreased downstream. Turbidity was usually zero. Benthic algae were primarily diatoms. Diatoms predominated except in spring, when a major bloom of *Hydrurus foetidus* occurred. Benthic algal standing crop varied inversely with water column concentrations of orthophosphorus, phosphorus and inorganic nitrogen. Measurements of primary production made in Clearwater creek were among the highest reported for streams in subarctic Alaska. Macroinvertebrate density in Clearwater creek was low. There are 38 references. U.S.A.

95-0618

**Mountain streams in Westland, New Zealand: benthic ecology and management issues.**

M. J. WINTERBOURN (Canterbury University, Christchurch) and P. A. RYAN

*Freshwater Biology*, 1994, 32, No 2, 359-374

The physico-chemical characteristics and benthic ecology of rivers and streams on the west coast of the South Island (Westland) of New Zealand are reviewed. The geography, river systems and water quality of the region are described. Stream waters are characterized by low concentrations of major ions. Brown waters with low pH and high concentrations of dissolved organic carbon are common at low and intermediate altitudes. The stream ecosystems are described with reference to hydrology and primary producers, carbon pathways, invertebrate fauna, and longitudinal distribution patterns. Hydrological factors and low nutrient concentrations limit periphyton standing crops and biomass of coarse detritus is often low. The macroinvertebrate in many streams are dominated by the mayfly (*Deleatidium*). The effects of coal mining, alluvial gold mining, and water exporting enterprises on the region are discussed. There are 81 references. New Zealand.

95-0619

**Quantifying anthropogenic nutrient sources and loadings within a small catchment with conservation interests, eastern Scotland.**

I. C. GRIEVE (Stirling University) and D. J. GILVEAR

*Aquatic Conservation*, 1994, 4, No 3, 273-287

Routinely available hydrological and hydrochemical data were used to assess the relative importance of potential anthropogenic nutrient sources in a catchment including 2 lochs and a floodplain mire. Nitrate was introduced from groundwater and phosphate and ammonia from surface water, but the major source for all was intensive agriculture. Phosphate inputs were increasing but nitrate might have stabilized. Nitrate appeared to be removed by the mire, thus reducing inputs to the lochs. Reduction of phosphate and nitrate inputs to the mire were the most important measures required to restore water quality. These would require changes in farming practice to reduce fertilizer usage and avoid fertilizer or slurry applications near water courses. U.K.

95-0620

**Nutrient dynamics in the deltaic floodplain of the Lower Parana river**

C. BONETTO (Instituto de Limnologia Dr. Ringuet, La Plata)

E. de CABO N. GABRIELONE, A. VINCIGUZZI, DONADELLI and E. UNREIN

*Archiv für Hydrobiologie*, 1994, 131, No 3, 277-295

There was a large suspended matter and nitrate decrease from the Lower Parana river to the floodplain lake, in permanent contact with the river, and to the surrounding marsh. Suspended reactive phosphorus (SRP) decreased from the river to the lake surface but increased in the suboxic lake bottom, the water hyacinth ring and the marsh. The inorganic nitrogen:SRP ratio decreased from 10 in the river to 5 on the lake surface to 3 in the water hyacinth ring to 1.2 in the lake bottom and 0.8 in the floodplain marsh. Bottom lake sediments had lower total nitrogen content than the incoming river suspended matter. Results suggest that the deltaic floodplains represent a sink of nitrogen and a course of SRP derived from river suspended matter. *Schoenoplectus californicus*, the dominant macrophyte in the marsh, was nitrogen limited. *Eichhornia crassipes*, the dominant macrophyte in the lake, may also be nitrogen limited. Phytoplankton biomass did not provide a conclusive pattern. There are 38 references. Argentina.

95-0621

**Diagenesis of organic matter in a wetland receiving hypereutrophic lake water. 1. Distribution of dissolved nutrients in the soil and water column**

J. M. D'ANGELO (Florida University, Gainesville) and K. R. REDDY

*Journal of Environmental Quality*, 1994, 23, No 5, 928-936

Waste water to wetlands technology was being evaluated to improve water quality in Apopka lake, FL, U.S.A. Lake water was pumped through a constructed marsh allowing settlement of particulate organic matter. The lake water had a retention time of 3-12 d in the marsh. Changes in the distribution of dissolved nutrients in the soil-water column were studied during 13 months following marsh creation. The *in situ* distribution of hydrogen ions, ammonium, soluble phosphorus, sulphate, dissolved organic carbon, dissolved inorganic carbon, methane, calcium, magnesium, manganese and aluminium was measured using soil pore water equilibrators at 3, 8 and 13 months after marsh creation. There was an accumulation of particulate matter on the native peat soil surface. The changes in

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groundwater concentrations of the measured parameters indicated that 4 principal processes were involved in nutrient release in the marsh: initial flushing of soil nutrients, mineralization of organic matter in the peat soil and settled flocculent sediment, anaerobiosis in the peat soil and flocculent sediment layers, and transport mechanisms across the soil-water interface. After 13 months of flooding, 75 per cent of the variability of ammonium nitrogen and 65 per cent of the variability of soluble phosphorus contained in the water and flocculent sediment was explained by dissolved inorganic carbon and methane carbon mineralized from settled organic matter (see also following abstract). U.S.A.

95-0622

**Diagenesis of organic matter in a wetland receiving hypereutrophic lake water: II. Role of inorganic electron acceptors in nutrient release.**

F. M. D'ANGELO (Florida University, Gainesville) and K. R. REDDY

*Journal of Environmental Quality*, 1994, 23, No 5, 937-943

Constructed marshes were being used to improve the water quality of Apopka lake, FL, U.S.A. The proportion of nutrients regenerated in aerobic and anaerobic pathways depended on the availability of electron acceptors in the marsh. Oxygen, nitrate and sulphate reduction rates in soil-water columns were determined in batch incubation experiments with recently deposited organic matter and peat soils from the constructed marsh. In electron amended soils, electron acceptor consumption decreased in the order: oxygen, nitrate, sulphate. Mean reduction rates for oxygen, nitrate and sulphate were 1.6, 0.23 and 0.086 g per m<sup>2</sup> d, respectively. If electron acceptor consumption was coupled to decomposition of organic matter in flocculent sediment with a carbon:hydrogen:phosphorus ratio of 190:14:1, aerobic catabolism accounted for 92 per cent of ammonium and soluble phosphorus regenerated in the soil. Anaerobic decomposition accounted for the remaining 8 per cent. Anaerobic decomposition was expected to be the dominant mechanism for nutrient regeneration in the constructed marshes. Under sulphate reducing conditions, net rates of organic nitrogen and phosphorus mineralization were 3.3, 1.4 and 0.5, 0.6 mg per litre, respectively. These rates were correlated to the production of dissolved inorganic carbon plus methane carbon (see also preceding abstract). U.S.A.

95-0623

**Annual nutrient exchanges between the central lagoon of Venice and the northern Adriatic sea**

A. SERISO (Department of Environmental Sciences, Venice), A. MARCOMINI and B. PAVONI

*Science of the Total Environment*, 1994, 156, No 1, 77-92

Nutrient exchange between the central lagoon of Venice and the Adriatic sea and the amounts of nutrients transported to the lagoon by the Osellina river were investigated. Water quality was monitored monthly at stations in the lagoon, the sea, and the Osellina river at rising and ebb tide. In the sea and lagoon stations there were negative correlations between water nutrient concentrations and chlorinity and between nutrient concentrations and oxygen saturation. Total inorganic nitrogen was 3-4 times higher in the sea than in the lagoon during February-September. During the same period, the inflow of total inorganic nitrogen through the Lido and Malamocco to the lagoon was 1-2 times higher than total loads entering the lagoon from freshwater sources. Phosphorus levels were higher in the sea than the lagoon during April-June. The sea was the principal supplier of nutrients for the spring-summer macroalgae growth in the lagoon. Total inorganic nitrogen and reactive phosphate inputs from the

Osellina river to the lagoon were 123 and 15.5 tons per year, respectively. These values were negligible in comparison with the total nitrogen and phosphorus amounts recycled by the gross primary production in the central lagoon. Italy

95-0624

**Characterization of surface water quality along a watershed disturbance gradient.**

R. A. ZAMPELLA (The Pinelands Commission, New Lisbon, N.J.)

*Water Resources Bulletin*, 1994, 30, No 4, 605-611

Water quality for 14 stream sites in the New Jersey Pinelands was characterized with respect to land disturbance using data from records which covered an 11-year monitoring period. An increasing land disturbance gradient based on land use intensity and wastewater flow showed a correlation with increased specific conductance and pH and in stream determinant concentrations including soluble magnesium and calcium, total ammonium-nitrogen, total nitrite and nitrate nitrogen and total phosphorus. These coincident gradients demonstrated the effects that catchment disturbance had on the natural water chemistry in the area. Planning and regulatory programmes for the Pinelands should take the results of this study into account. U.S.A.

95-0625

**Prioritizing nonpoint source phosphorus loading using a GRASS-modelling system.**

Z. CHEN (Environmental Systems and Technology, Inc., Blacksburg, VA), D. E. STORM, M. D. SMOLEN, C. T. HAAN, M. S. GREGORY and G. J. SABBAGH

*Water Resources Bulletin*, 1994, 30, No 4, 589-594

A nonpoint source phosphorus model was integrated with a geographic resource analysis system (GRASS) using a dedicated UNIX based windows application. The system modelled phosphorus application in fields or cell units in a catchment and evaluated the effects of watershed management regimes on phosphorus yields. The phosphorus model accounted for hydrologic and geographical data together with phosphorus loading inputs. System output predictions included dissolved and sediment attached phosphorus, sediment volumes and runoff. The system input and output data could be displayed as GRASS based maps or tables. U.S.A.

95-0626

**Dynamics of ammonium and nitrate uptake in the water column of the Neuse river estuary, North Carolina.**

L. N. BOYER (East Carolina University, Greenville, N.C.), D. W. STANLEY and R. R. CHRISTIAN

*Estuaries*, 1994, 17, No 2, 361-371

The dissolved inorganic nitrogen dynamics of the Neuse river estuary, N.C., were investigated by measuring ammonium and nitrate uptake rates and calculating daily depth integrated rates at 7 stations distributed along the salinity gradient over a 4-year period. Dark ammonium uptake varied both spatially and seasonally and accounted for up to 95 per cent of the light uptake. Dark uptake of nitrate was only 14 per cent of the maximal light uptake. In general, nitrate uptake was only 20 per cent of total dissolved inorganic nitrogen uptake. The total annual uptake was more than twice published estimates of phytoplankton demand. There are 46 references. U.S.A.

95-0627

**Denitrification in riparian wetlands receiving high and low groundwater nitrate inputs.**

G. C. HANSON (Institute of Ecosystem Studies, Millbrook, NY), P. M. GROFFMAN, and A. J. GOLD

*Journal of Environmental Quality*, 1994, 23, No 5, 917-922

Denitrification rates were compared in 2 riparian forest sites situated on the east and west sides of a small stream in Rhode Island, U.S.A. The sites had similar soils, vegetation, and hydrology. One site (enriched) was situated below an intensive residential development with on-site septic systems. The other site (control) was undeveloped. Denitrification was measured using an acetylene-based intact core technique under unamended, water amended, and water plus nitrate-amended conditions. Denitrification (unamended and amended) and soil and groundwater nitrate levels were higher in soils on the enriched site. Annual denitrification was estimated as less than 5 and 40 kg nitrogen per ha on the control and enriched sites, respectively. Denitrification removed an estimated 50 per cent of groundwater nitrate that entered the enriched site. There are 38 references. U.S.A.

95-0628

**Nitrate contamination from dairy lagoons constructed in coarse alluvial deposits.**

S. F. KOROM (North Dakota University, Grand Forks)

*Journal of Environmental Quality*, 1994, 23, No 5, 973-976

The development of eutrophic conditions in Deer Creek reservoir, Utah, U.S.A. led to dairies in Heber valley constructing unlined lagoons to store wastes for later application to fields as fertilizer. Early studies on earthen dairy lagoons on relatively coarse textured soils showed minimal adverse effects on groundwater quality. The dairy lagoons in the Heber valley were on even coarser soils. The dairy lagoons were evaluated as sources of nitrate to the Heber valley aquifer. Leachate samples obtained from 2 dairy lagoons during 1989-1991 were analysed for nitrate, nitrite and ammonium. All nitrate concentrations were less than or equal to 1 mg per litre and most ammonium concentrations were less than or equal 5 mg per litre. These levels exceeded U.S. drinking water standards and were higher than those reported in the literature. The unlined lagoons allowed excessive nitrate contamination to leach into the Heber valley aquifer and should not be constructed on such coarse soils. U.S.A.

95-0629

**Zebra mussel (*Dreissena polymorpha*) populations in the Seneca river, New York: impact on oxygen resources.**

S. W. EFFLER (Upstate Freshwater Institute, Syracuse, NY) and C. SIEGFRIED

*Environmental Science & Technology*, 1994, 28, No 12, 2216-2221

The dissolved oxygen in a 16 km low turbulence reach of the Seneca river was studied in the summer of 1993. Considerable depletion was noted, the median of 4.5 mg oxygen per litre being 2.5 mg per litre less than for 1990-1991. No unusual conditions or pollution were observed and the explanation appeared to be a severe infestation of zebra mussels. Densities of 33,000-61,000 individuals per m<sup>2</sup> were found in a 1.4 km section. The estimated respiration rate of 34 g per m<sup>2</sup> d nearly matched the loss calculated independently from dissolved oxygen budget calculations of 44 g per m<sup>2</sup> d. The mussels increased water clarity by removing phytoplankton. Further infestations were expected in hard water streams with rock substrates. U.S.A.

95-0630

**Temporal and spatial variations in sediment characteristics on the Mississippi-Alabama continental shelf.**

M. C. KENNICUTT (Texas A&amp;M University, College Station), W. W. SCHROEDER and J. M. BROOKS

*Continental Shelf Research*, 1994, 15, No 1, 1-18

Surficial sediments on the Mississippi-Alabama continental shelf were examined to determine the sources, distribution and variability of selected sediment characteristics. The inorganic and organic chemistry of sediments at 4 stations on each of 3 transects of the shelf was documented over a 2 year period. Some sediment properties varied by more than an order of magnitude over the period. Individual sediment components varied independently and could be described as cyclic, steadily increasing, random or unchanging. Many variations were linked to influxes of terrestrial material associated with river discharges into the Mexico gulf. There are 36 references. U.S.A.

95-0631

**Sewage problems in Lugano.**

I. KARAGOUNIS (Vereinigung für Gewässerschutz und Ökthygiene, Zurich), A. BARBIERI, M. SIMONA, and M. CAMANI

*Wat. Wiss. Abwasser*, 1994, 74, No 9, 740-747 (in German, English summary)

The deterioration in the water quality in the Gulf of Agno at the western extremity of Lugano lake is discussed. The anoxic conditions prevailing in the bottom waters at certain times of the year and a high level of bacterial contamination had necessitated a ban on bathing from several beaches in the vicinity. The poor water quality was directly linked to inputs of nutrients and micro-organisms from the sewage treatment plant (rated capacity 112 500 PE) which discharged to the Veduggio river only a short distance from its point of entry into the lake. Nutrient loadings contributed to a partial eutrophication of the water body and the morphological characteristics of the Gulf of Agno limited the exchange of water with other parts of the lake. To reduce the level of pollution, an extension of the sewage treatment plant was proposed which would incorporate a fourth stage comprising both nitrification and flocc-filtration. This was expected to substantially reduce nitrogen and phosphorus inputs along with reducing the amounts of BOD in the treated effluent by 30-60 per cent plus a 5-10 fold reduction in bacterial counts. When this stage comes on stream in 1995 a marked water quality improvement in the lake was expected. However if the level of improvement was insufficient, various alternative options for diverting the flow of treated effluent must be considered. (English translation 235 pounds sterling, valid for 1995). Switzerland

95-0632

**Multivariate directional analysis of the quality of rainfall in the Quebec region.**

C. LABERGE (INRS Eau, Sainte-Foy, P.Q.), D. CLUIS, and G. M. SAULNIER

*Revue des Sciences de l'Eau*, 1994, 7, No 3, 269-284 (in French, English summary)

Studies of the relationship between the composition of rainfall recorded in the vicinity of the city of Quebec and the direction from which the wind was blowing are reported. The databank used in the statistical analysis contained 10 time series of the weekly concentrations of 9 constituents (hydrogen, calcium, chlorine, potassium, magnesium, sodium, nitrate, ammonium and sulphate) of rainfall collected at the local meteorological station and a series of weekly

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prevailing winds measured at the nearby city airport. This series contained 312 observations covering a full 6-year period between December 1981 and December 1987. The weekly concentration values were obtained by averaging from daily sample collections and analysis, and classical statistical procedures were used to analyse correlations between specific constituents and prevailing wind directions. The principal acidic constituents (nitrate, sulphate) were significantly correlated with winds of westerly origin, while other constituents (calcium, magnesium, chlorine) reputed to be of oceanic origin were correlated with winds from an easterly direction. The results confirmed the popular hypothesis that acid precipitation in the Quebec region originated from the industrial atmospheric emissions in the mid-west region of the U.S.A. (English translation 265 pounds sterling, valid for 1995). **Canada**

### 95-06.33

#### **Procedures for estimation of the degree of risk from discharges of combined sewage to watercourses**

D. BORCHARDT (Universität Gesamthochschule Kassel), C. XANTHOPOULOS and G. WARG

*Wasserwirtschaft* 1994, **84**, No 9, 480-486 (in German, English summary)

The degree of impairment of water quality in a receiving stream resulting from the input of combined sewage in response to isolated storm events was estimated using 3 different procedures, on the basis of rainfall data and discharge profiles for rivers of different size in different parts of Germany. The results enabled events differing in the severity of pollution to be classified according to their expected frequency coupled with an assessment of the major pollution components with respect to their near and far field effects, as a function of time, and also both retrospective and prospective evaluations of the consequences of combined sewer overflows. The productive capabilities of the different approaches are considered and depended on the level of detail in the underlying databases. The significance of some of the most commonly adopted simplifying assumptions is discussed and comments are advanced in respect of certain desirable improvements. The methods employed were not suited to estimation of the impacts on stream ecology at points a long way downstream from the site of the overflow. (English translation 320 pounds sterling, valid for 1995). **Germany**

### 95-06.34

#### **Water quality during storm events from two constructed wetlands receiving mine drainage**

L. R. STARK (Pennsylvania State University, University Park), R. P. BROOKS, T. M. WILLIAMS, S. E. STEVENS and L. K. DAVIS

*Water Resources Bulletin* 1994, **30**, No 4, 639-650

At 2 constructed wetlands receiving mine drainage water, flow rates, pH and concentrations of iron and manganese were measured during several episodes of heavy rain. Discharge rates exceeded inflows at both sites during periods of substantial rainfall, reflecting incident precipitation at the sites. At the Luger site there was positive correlation between discharge flow and local rainfall but not between inflow and rainfall. During storm events, discharge pH was higher than inlet pH for the larger wetland but over the year there was no correlation between pH and rainfall. The discharge pH at the smaller wetland was depressed in relation to inlet pH during storm events. Heavy rainfall had little effect on iron concentration in outlet flows in the larger wetland but at the smaller wetland outlet iron concentration increased temporarily, with concurrent decline in treatment efficiency to nearly zero. A correlation between iron concentration

and discharge flow rate was found for the larger wetland. Manganese removal efficiency of 50 per cent for the smaller wetland was maintained during light rain but was reduced to zero by heavy rainfall. **U.S.A.**

### 95-06.35

#### **Palaeolimnological evidence for the acidification and contamination of lakes by atmospheric pollution in western Ireland**

R. J. FLOWER (University College London, U.K.), B. RIPPEY, N. I. ROSE, P. G. APPLEBY and R. W. BATTARBEE

*Journal of Ecology* 1994, **82**, No 3, 581-596

Sediment cores and water samples were collected from 4 lakes in Ireland, and dated by lead-210 testing. Diatom analysis showed that the 2 upland lakes were undergoing acidification. Trace metal and carbonaceous particles in the sediment showed that atmospheric contamination began in the 1860s at Muck Lough and between 1890 and 1910 at the other sites. Acid deposition explains the acidification of the upland lakes while local alkalinity sources had limited the effects on the lowland lakes. Models of acidification gave poor predictions for the lakes because sulphur deposition estimates and water chemistry data were inadequate. Palaeolimnological records provided definite evidence of acidification and history of ecological change at unmonitored sites. There are 66 references. **Ireland**

### 95-06.36

#### **Coupling of hydrologic transport and chemical reactions in a stream affected by acid mine drainage**

B. A. KIMBALL (U.S. Geological Survey, Salt Lake City, Utah)

R. E. BROSHIARS, K. E. BENICAI and D. M. McKNICHI

*Environmental Science & Technology* 1994, **28**, No 12, 2065-2073

The discharge and residence time in a 1497m reach of a stream receiving acid mine drainage were determined with a lithium chloride tracer. The transport of metals from inputs of acidic metal-rich water was evaluated on the basis of synoptic samples of metal concentrations and hydrological characteristics. Transport of sulphate and manganese was generally conservative, but in the sub-reaches most affected by acidic inflows it was reactive. Iron in all forms was reactive over most of the stream reach. High concentrations of aluminium partitioned onto particles. The steady state profiles of sulphate, manganese, iron and aluminium were simulated by first order reactions. Several processes occurring on a stream reach scale were incorporated into the calculated rate constants for net removal. Chemical reactions were only important over short distances in the stream near the acidic inflows where they occurred on a timescale comparable with hydrological transport. There are 33 references. **U.S.A.**

### 95-06.37

#### **Trace and toxic metals in wetlands - a review**

R. P. GAMBRIEL (Louisiana State University, Baton Rouge)

*Journal of Environmental Quality* 1994, **23**, No 5, 883-891

Processes affecting the mobility and plant availability of trace and toxic metals in wetlands are reviewed. In metal contaminated land the principal processes are release of metals to surface water from sediments and flooded soils, metal uptake by wetland plants, metal accumulation by benthic and wetland animals, runoff losses, and leaching losses. The effects of soil oxidation/reduction status and soil pH on metal mobility and bioavailability are reviewed. The chemical forms and transformations of metals in soils and sediments are discussed. Research on the bioavailability of metals is reviewed. Early studies focused on metal availability to rice and metal uptake

by plants from sludge-amended soils and dredged materials. Recent research has focused on the mobility and bioavailability of metals from dredged material. Plant uptake, leaching losses, and surface runoff losses have been shown to be significant migration pathways for metals in uplands. Metals tend to be retained more strongly in wetland soils compared with plant soils. Areas for future research are identified. There are 50 references. U.S.A.

95-0638

**A note on the occurrence of metals in the Olifants river, Eastern Transvaal, South Africa.**

D. F. GROBLER (Department of Water Affairs and Forestry, Pretoria), P. L. KEMPSTER and L. van der MERWE  
*Water SA* 1994, 20, No 3, 195-204

Fish, water and sediment samples were collected from the middle and lower reaches of the Olifants river and analysed for 20 trace metals to form part of baseline data for future assessment of the river's pollution status. Arsenic, cadmium, lead and mercury were not detected. Fifteen metals were detected in sediment samples, 7 in fish muscle tissue, and 15 and 16 in the dissolved and acid extractable fractions, respectively. Generally, concentrations of the metals were low. Suspended sediment provided binding sites for the metals making them unavailable to aquatic organisms. South Africa

95-0639

**Trace metal levels in water, sediment and *Chironomus gr. thummi*, from different water courses in Flanders (Belgium).**

J. BERVOETS (Antwerp University, Wilrijk), J. INTJANIS and R. VERHEYEN  
*Chemosphere* 1994, 29, No 8, 1591-1601

Trace metals (cadmium, lead, copper, zinc) were measured in water, sediment and fourth instar larvae of the midge *Chironomus gr. thummi* collected from 12 sampling stations on 8 watercourses of different types in Flanders, Belgium. Larval, sediment and larval/water relationships were investigated using Spearman rank correlations. For water samples, the pH was 4.9-8.1. Hardness was 28.9-44.9 mg calcium carbonate per litre. Metal concentrations were  $\mu\text{g/L}$  per litre: cadmium 0.1-8.9 with one high value of 25.4, lead 0.1-15.9 with one outlier of 384, copper 0.3-14.5 with an outlier of 264, and zinc 8-445. All the outliers were measured on the same sampling station. In sediment samples metal concentrations were  $\mu\text{g/g}$  per gram: cadmium 0.2-52.1, lead 2.1-180, copper 1.5-71.1, zinc 4.7-66.2. Metal levels in the larvae differed strongly between the different sampling sites. No sediment/larvae or water/larvae relationships were found except for cadmium where there was a significant relationship between metal levels in water and in chironomids. When the outlier site was omitted, the relationship was no longer significant. Belgium

95-0640

**Effects of ion exchange on stream solute fluxes in a basin receiving highway deicing salts.**

J. B. SHANLEY (U.S. Geological Survey, Montpelier, VT)  
*Journal of Environmental Quality* 1994, 23, No 5, 977-986  
In 1983 the U.S. Geological Survey initiated a study to determine the effects of atmospheric wet deposition on streamwater quality in 2 basins supplying the Quabbin Reservoir, Mass., U.S.A. One basin, Fever brook, was heavily affected by highway deicing salts. A geochemical mass balance for Fever brook suggested that some of the sodium in applied salt exchanged for and released calcium and magnesium to streamwater. A method was developed to quantify the

exchange and derive the cation fluxes (background fluxes) that would have occurred in the absence of applied salts. The background fluxes of calcium and magnesium were calculated by subtracting the amounts from ion exchange plus the smaller direct contributions in deicing salts from the observed fluxes. Ion exchange and direct salt contributions increased the net output fluxes of calcium and magnesium by 44 per cent each. Failure to account for cation exchange could result in underestimating the flux of sodium from weathering and overestimating the fluxes of calcium and magnesium from weathering. There are 44 references. U.S.A.

95-0641

**Lead, arsenic, cadmium and copper in lake Asososca, Nicaragua.**

A. C. CRUZ (Research Center for Aquatic Resources of Nicaragua, Managua), J. S. THOMSGAARD and J. LAAYO  
*Science of the Total Environment* 1994, 155, No 3, 229-236

Water and surface sediment samples were collected every 3 months for a year from 5 sites in Asososca lake, and the lead, arsenic, copper and cadmium concentrations were measured. Lead concentrations in the water were all below the limits for drinking water but there were significant differences between sampling times. Arsenic, copper and cadmium concentrations were all within normal ranges. The concentrations of cadmium and copper in sediment samples were similar at all sites, but those of lead and arsenic were higher at the pumping station than in the rest of the lake. It appeared that industries near the lake had not significantly increased the heavy metal concentrations at the time of testing. Nicaragua

95-0642

**Arsenic transport in a watershed receiving gold mine effluent near Yellowknife, Northwest Territories, Canada.**

D. A. BRIGHT (Royal Roads Military College, Victoria, B.C.), B. COLDY, W. T. DUSHENKO and K. J. REIMER  
*Science of the Total Environment* 1994, 155, No 3, 237-252

The environmental partitioning and speciation of inorganic arsenic from gold mine effluent was studied in water and sediment samples taken from 5 small lakes and from sites in Yellowknife bay, Northwest Territory. Maximal concentrations of inorganic arsenic in the water column, sediment, particulates and pore water were found about 4 to 6 km downstream from the mine. Arsenite (valency III) was the predominant arsenical in sediment, pore water, whereas arsenate (valency V) was the major form in the water column. Comparison with other elements discharged from the mine suggested that bulk movement of sediments was a major factor in the redistribution of inorganic arsenic. The very high concentrations in sediment, pore water and the water column further from the input were attributed to redox-related dissolution from the sediments. There are 33 references. Canada

95-0643

**Mercury contamination and floodplain sedimentation from former gold mines in north Georgia.**

D. S. FLEIGH (Georgia University, Athens)  
*Water Resources Bulletin* 1994, 30, No 4, 739-748  
Gold mining in the Dahlonega gold belt in north Georgia, in the period 1820 to 1940, caused widespread mercury contamination in alluvial deposits arising from the amalgam process used for gold extraction. Near the centre of the gold mining district, mercury contamination in floodplain sediments exceeded background levels of 0.04 mg per kg by up to 2 orders of magnitude, decreasing downstream from the core mining area. The polluted sediments were

## WATER QUALITY

a significant non point source of mercury contamination. Mining of saprolite by high pressure hosing after 1868 and timber felling for the mining settlements caused rapid sedimentation and floodplain aggradation. When mining ceased streams adjusted by terraced alluvial deposition. The terrace later became eroded by stream migration. Major floods caused channel erosion within the contaminated alluvium transferring high sediment loads to reservoirs. U.S.A

95-0644

### **Volatile compounds in meromictic Antarctic lakes and basins.**

N. J. ROBERTS (Tasmania University, Australia) and H. R. BURTON

*Chemosphere* 1994, **29**, No 8, 1627-1637

Thirteen meromictic Antarctic lakes and basins were sampled for volatile compounds during 1991. The sample sites were Ace lake, Burton lake, Deep basin, Deprez basin, Franzmann lake, Fletcher lake, Williams lake, Anderson lake, Ekko lake, Shield lake, Johnstone lake, Organic lake and Laternula lake. Volatile compounds were extracted and determined by headspace analysis and GC with mass selective detection. The sites varied in surface area, organic carbon input, microbiota, depths, densities, redox potentials and temperatures. With the exception of Ekko lake, the highest concentration of volatile compounds was in the bottom metre. In Ekko lake the highest concentrations were 13 m above the sediment. Nineteen volatile compounds were identified and a further 8 were tentatively identified. Compounds identified included dimethyl sulphide, C<sub>5</sub>-C<sub>12</sub> polysulphides, substituted benzenes, thiophenes, octane and 6-methyl-5-hepten-2-one. The species of volatiles in each site was correlated with its physical characteristics. Density was the predominant environmental factor influencing the distribution of volatile compounds. Antarctica

95-0645

### **Herbicides in the Great Lakes.**

S. P. SCHOTTLER (Minnesota University, Navarre) and S. J. EISENRIICH

*Environmental Science & Technology* 1994, **28**, No 12, 2228-2232

Water column profiles of herbicide concentrations at 4-10 depths per site were constructed at 26 sites in Michigan, Huron, Erie and Ontario lake in September 1991 and August 1992. The herbicides were concentrated with C-18 solid phase cartridges, extracted with ether and analysed by gas chromatography-mass spectrometry. Alachlor, metolachlor, atrazine and its transformation products, desethyl atrazine (DEA) and desisopropyl atrazine were measured. Concentrations of atrazine and DEA were at ng per litre level, indicating around 600,000 kg was present in the Great Lakes. Atrazine was completely mixed both vertically and laterally, suggesting long residence times and half-lives of months to years. U.S.A

95-0646

### **Transport of nutrients and postemergence-applied herbicides during corrugation irrigation of wheat.**

A. J. CESSNA (Agri-Food Canada Research Station, Regina, Sask.) J. A. ELLIOTT, L. A. KERR, K. B. BEST, W. NICHOL, AICHUK and R. GROVER

*Journal of Environmental Quality* 1994, **23**, No 5, 1038-1045

The presence of nutrients and/or pesticides in runoff from surface irrigations could adversely affect the quality of the receiving waters. The transport in runoff of 3 post-emergence herbicides (dicamba, MCPA and diclofop) and nitrogen and phosphorus following 2

corrugated irrigation treatments of a field in Saskatchewan, Canada planted with wheat (*Triticum aestivum*) was studied. Phosphorus and nitrogen losses corresponded to 0.29 and 0.13 per cent of the amounts applied through fertilization. Losses in the first irrigation were approximately double those in the second. Losses of dicamba, MCPA and diclofop from the site corresponded to 0.2 per cent of the amount of each herbicide applied to the wheat. Approximately 97 per cent of the losses occurred during the first irrigation. Maximal phosphorus and diclofop concentrations exceeded drinking water guidelines and those for dicamba and MCPA exceeded interim guidelines for irrigation water. Canada

95-0647

### **Transportation of pesticides in estuaries of the Axios, Loudias and Aliakmon rivers (Thermaikos Gulf), Greece**

T. A. ALBANIS (Ioannina University), T. G. DANIS and M. K. KOURGIA

*Science of the Total Environment* 1994, **156**, No 1, 11-22

Sediment and water samples from 8 sites in the wetland of the delta of the Axios river, Loudias river and Aliakmon river were collected in 1992-1993 and analysed for organochlorine insecticides, neutral herbicide compounds and acidic herbicide compounds by GC. Eleven herbicides, alachlor, atrazine, 2,4-D, diuron, MCPA, metolachlor, metribuzin, molinate, prometryne, simazine and trifluralin were identified in the water samples. Three organochlorine compounds,  $\alpha$ -BHC, lindane and 4,4'-DDT were also detected. Alachlor, atrazine, metolachlor, molinate, simazine, trifluralin,  $\alpha$ -BHC, lindane and 4,4'-DDT were detected and showed significant accumulation in sediments which contained 3.4-5 per cent organic matter. Peak concentrations generally corresponded to their application in the fields. The annual amounts of each pesticide which was transported in the Thermaikos Gulf waters were calculated. The percentages of the total amount of pesticides released into the Thermaikos Gulf via the rivers were estimated as 1.7 and 0.78 per cent for alachlor, 2.5 and 1 per cent for atrazine, 1.1 and 0.1 per cent for metolachlor, 7.4 and 2.5 per cent for metribuzin, 4.5 and 4.4 per cent for prometryne, 0.3 and 0.06 per cent for trifluralin and 0.3 and 0.25 per cent for lindane for 1992 and 1993 respectively. Greece

95-0648

### **A note on PCBs and chlorinated hydrocarbon pesticide residues in water, fish and sediment from the Olifants river, Eastern Transvaal, South Africa**

D. T. GROBLER (Department of Water Affairs and Forestry, Pretoria)

*Water SA* 1994, **20**, No 3, 187-194

Fish, water and sediment samples from the middle and lower reaches of the Olifants river were analysed for 10 chlorinated pesticides and 2 PCBs. No PCB or chlorinated pesticides were detected in the water samples and levels in sediment samples were too low for confirmation by mass spectrometry. DDT and its metabolites (DDE and DDD) were found in fish samples. Organisms high up the food chain had increased body burden indicating bioaccumulation. Contamination levels were similar throughout the river system and lower than internationally reported levels. South Africa

95-0649

**A survey of southern England coastal waters for the s-triazine antifouling compound Irgarol 1051.**

M. A. GOUGH (National Rivers Authority, Waterlooville), J. FOTHERGILL, and J. D. HENDRIE

*Marine Pollution Bulletin*, 1994, 28, No 10, 613-620

Water samples were collected from marinas, estuaries and coastal waters in Kent, Sussex and Hampshire, and sediment samples from the Hamble estuary, and analysed for the s-triazine Irgarol 1051 and the triazines simazine and atrazine. Irgarol 1051 was detected in most of the samples except those from rivers, with highest concentrations in areas of high boating activity, particularly marinas, and the Hamble estuary. Sediment contamination with Irgarol 1051 was found where the concentration in the water column was high. The concentrations of simazine and atrazine were highest in river and estuarine samples, reflecting their agricultural use. U.K.

95-0650

**Molecular mass distributions of dissolved organic carbon and associated metals in waters from Rio Negro and Rio Solimoes**

E. L. KUCHLER (Fluminense Federal University (UFF), Niteroi), S. M. KEFELEY, and B. R. FORSBERG

*Science of the Total Environment*, 1994, 156, No 3, 207-216

Using ultrafiltration techniques, 30-40 per cent of the DOC in the Rio Negro was shown to be within the mass range of 1-10 kDa. This fraction was composed principally of humic compounds, the carriers for most of the metal ions studied. Humic and fulvic acids isolated from these waters were characterized by infrared spectrometry and potentiometric titrations. The waters of the Rio Solimoes had higher concentrations of the major elements (calcium, potassium, magnesium and sodium), lower DOC retention (about 20 per cent) and a different size distribution of colloidal carbon and metals than the Rio Negro. Some of the problems experienced in the use of hollow fibre columns and their flat membrane filters for the separation of humic compounds from natural waters are discussed. Brazil.

95-0651

**An assessment of the impact of inland surface water input to the bacteriological quality of coastal waters.**

M. D. WYER (Leeds University), G. JACKSON, D. KAY, J. YEO, and H. DAWSON

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 5, 459-467

The source of indicator organisms to St Aubin's bay, Jersey, was investigated following failure to meet the EC Bathing Water Directive's standards. The UV-disinfected sewage effluent complied with its design criterion of 200 faecal coliforms per 100 ml. Seventeen watercourses flowing into the bay and sites of seepage from beneath slipways were sampled. Faecal indicator counts were measured under a range of flow conditions using standard U.K. methods. Geometric mean concentrations of coliform organisms were 1-4 orders of magnitude higher in the streams than in the sewage effluent. Quality declined with increased discharge. Seepage contributed few micro-organisms. Quality objectives in coastal waters would only be achieved by an integrated approach to catchment management which addressed domestic and agricultural sources of indicator organisms. U.K.

95-0652

**Predicting likelihood of gastroenteritis from sea bathing: results from randomised exposure**

D. KAY (Leeds University), J. M. T. FISHER, R. T. SALMON, E. JONES, M. D. WYER, A. F. GODFREY, Z. ZEIN ALCH JACQUOTTE, and R. SHORI

*Lancet*, 1994, 344, No 8927, 905-909

A randomized trial of sea bathing was conducted with 1216 adult volunteers at 4 U.K. resorts. All volunteers were interviewed to collect evidence about potential confounding factors, and 548 were randomized to bathe, including total immersion of the head. Of the exposed group 14.8 per cent developed gastroenteritis, compared with 9.7 per cent of the unexposed. Of a range of microbiological indicators measured, only faecal streptococci showed a significant dose response relationship with gastroenteritis. Although faecal streptococci are not suggested as the causative agent, they might be a better indicator of whether sea water was fit for bathing than coliforms. There are 36 references. U.K.

95-0653

**Mercury and methylmercury in population risk groups on the Atlantic coast of southern Spain.**

M. LOPEZ ARTIGUELA (National Institute of Toxicology, Seville), A. GRILO, D. MARTINEZ, M. L. SORIA, E. NUÑEZ, A. RUANO, E. MORINO, E. GARCIA FUENTE, and M. REPELLO

*Archives of Environmental Contamination and Toxicology*, 1994, 27, No 3, 415-419

The habit of fishermen from 2 different coastal areas in the highly industrialized south Atlantic coastal area of Spain had geometric means of 10.41 and 8.36 µg total mercury per g and 8.28 and 6.72 µg methylmercury per g. Mercury content in both groups differed significantly from controls (geometric mean 2.5 µg total mercury per g and 4.50 µg methylmercury per g). Pregnant women from 2 coastal areas and controls had geometric means of 2.40, 5.94 and 0.94 µg total mercury per g and 1.93, 4.78 and 0.82 µg methylmercury per g. Fish and molluscs most consumed by people in these groups had the following values for total mercury and methylmercury, respectively: swordfish 1.57 plus or minus 1.27 and 1.20 plus or minus 0.94 µg per g; *Scorpaenularia plana* 0.07 plus or minus 0.052 and 0.053 plus or minus 0.039 µg per g; *Lepus decussatus* 0.046 plus or minus 0.20 and 0.039 plus or minus 0.018 µg per g. There are 32 references. Spain.

95-0654

**Cryptosporidium's persistent powers for the water industry**

*ENRIS Report*, 1994, No 237, 18-21

The causes of the Milwaukee outbreak of cryptosporidiosis confirmed experiences in the U.K., combining a severe challenge to filtration systems with a works operating under unusual or strained conditions. Monitoring of cryptosporidium in raw and treated water in the U.K. showed that oocysts could be present in treated water at up to 2.86 per litre without increasing detectable disease levels. However, these levels could still represent a significant risk to public health by causing low and sporadic infections in vulnerable groups with impaired immune systems. The water industry needed to examine their policy as to whether vulnerable groups should be advised to boil their drinking water. Despite research efforts, cryptosporidium was difficult to detect and monitor. No standards yet existed. Improved treatment methods were needed. Membrane filtration and synthetic wound fibre filters were promising. Ozone



## MONITORING AND ANALYSIS

disinfection was no longer considered practical because of the high doses needed. U.K.

### 95-0655

#### **Municipal drinking water and cryptosporidiosis among persons with AIDS in Los Angeles County**

F. SORVILLO (Los Angeles County Department of Health Services, Calif.), F. LILJEBLAD, B. NAHLIN, J. MILLER, L. MASCOLO and L. RASH

*Epidemiology and Infection*, 1994, **113**, No 2, 313-320

The prevalence of cryptosporidiosis among people with acquired immune deficiency syndrome (AIDS) in Los Angeles County was assessed by water supply area. One water supplier, serving 60 per cent of the population (area B) had used flocculation and filtration for many years, while the other in area A did not do so until 1986. From 1984-1986 the prevalence in area A was 4.2 per cent, while in area B it was 6.2 per cent. After the application of filtration in area A the prevalence fell by 20 per cent, but there was a concurrent fall in area B of 47 per cent. This suggested that water filtration did not affect cryptosporidiosis risks for persons with AIDS. U.S.A.

### 95-0656

#### **Probabilistic health risk assessment for exposures to estuary sediments and biota contaminated with polychlorinated biphenyls, polychlorinated terphenyls and other toxic substances**

M. R. ADAMS (Ebasco Environmental, Arlington, Va.), C. A. HANNA, J. A. MAYERNIK and W. M. MENDELZ

*Risk Analysis*, 1994, **14**, No 4, 577-594

The health risks of exposure to contaminated sediments and biota were assessed using a Latin Hypercube probabilistic risk assessment method. The site studied was an estuary in Virginia contaminated with PCB, polychlorinated terphenyls (PCT) and PAH, mostly originating locally, and metals released from a storm sewer system. The exposure pathways associated with the highest contaminant intakes were dermal contact with sediment and consumption of contaminated aquatic and terrestrial biota. The major risks were from PCT. A probabilistic approach was used for contaminant exposure and intake assessment but a deterministic linear model had to be used for the toxicological modelling. All of the output probability distributions of risk were highly skewed, with ratios of mean to median risks ranging from 1.4 to 14.8. There are 32 references. U.S.A.

## MONITORING AND ANALYSIS OF WATER AND WASTES

See also Abstracts 95-0648, 95-0856, 95-0983, 95-0989, 95-0995

### 95-0657

#### **Pertinence of indicator organisms and sampling variables to *Vibrio* concentrations**

F. G. L. KOH (Florida State University, Tallahassee), J. H. HUYNH and P. A. LAROCK

*Applied and Environmental Microbiology*, 1994, **60**, No 10, 3897-3900

The most probable technique was used with an enrichment step to enumerate *Vibrio* species in water samples collected monthly from 2 stations in shellfish harvesting areas for 1 year. No vibrios were detected in samples collected at water temperatures below 10°C or salinity values below 5 ppt and the only correlations between counts

of vibrios and those of indicator bacteria (total coliforms, *Escherichia coli* and enterococci) determined by standard methods and U.S. EPA procedures were negative. In two 1-d field experiments samples were collected through complete tidal cycles at the water surface and bottom of a site with a semidiurnal tidal cycle. Three-way analysis of variance indicated that *Vibrio* concentrations were affected significantly by day, depth and tidal cycle and these factors should be considered if direct monitoring of *Vibrio* levels in shellfish harvesting waters or sediments became adopted. U.S.A.

### 95-0658

#### **Characterization of *Acinetobacter* type strains and isolates obtained from wastewater treatment plants by PCR fingerprinting**

M. WILDMANN, A. AHMAD (Institut für Biologie II/Mikrobiologie, Freiburg), H. V. TICHY and G. SCHÖN

*Applied and Environmental Microbiology*, 1994, **60**, No 11, 4066-4071

Polymerase chain reaction (PCR) fingerprinting technology was used to differentiate *Acinetobacter* type strains and isolates from wastewater treatment facilities. PCR fingerprinting was used on the first level with 2 rRNA gene specific primers to identify species, while on the second level a single arbitrary primer was employed for strain differentiation. A comparison of *Acinetobacter* type strains with 28 sewage sludge isolates allowed 27 isolates to be classified within specific species. Only one isolate could not be classified as one of the type strains. The PCR fingerprinting method was a reproducible and rapid method of differentiating and identifying isolates. Germany.

### 95-0659

#### **A simple and widely applicable method for preparing homogeneous and stable quality control samples in water microbiology**

J. E. SCHIVVEN (National Institute of Environmental Protection and Public Health, Bilthoven), A. H. HAVELAAR and M. BATHAR

*Applied and Environmental Microbiology*, 1994, **60**, No 11, 4160-4162

A method of preparing homogeneous test samples which remained stable for at least 1 year and could be applied in any microbiology laboratory using standard equipment including a minus 70°C freezer was developed. The method involved suspending test strains in skimmed milk, rapid freezing in dry ice, ethanol and storage at minus 70°C. The test samples produced were immediately stable and could be used directly, following only quick thawing in a water bath at 30°C. Test strains successfully stored were *Enterobacter aerogenes*, *Enterobacter faecium* and *Pseudomonas aeruginosa*. The only exception in terms of stability was *Aeromonas hydrophila* which showed a 20-30 per cent decrease in 1 year. Netherlands.

### 95-0660

#### **New composite biocarriers engineered to contain adsorptive and ion-exchange properties improve immobilized-cell bioreactor process dependability**

D. R. DURHAM, W. R. GRACE & Co. (Conn., Columbia, Md.), L. C. MARSHALL, J. G. MILLER and A. B. CHMURNY

*Applied and Environmental Microbiology*, 1994, **60**, No 11, 4178-4181

A type of zeolite-based biocarrier exhibiting ion-exchange properties and buffering microbial populations from acid and base pH system shocks and nutrient limitation, so enabling immobilized microor-

organisms to recover rapidly from conditions of oxygen deficiency and organic overloads was described earlier. This carrier, known as Type Z, was modified by the incorporation of activated carbon, giving it buffering properties towards a range of process upsets. The new carrier, Type CZ, promoted dense microbial growth and maintained bioreactor productivity. The protection of immobilized bacteria from organic shock loads and extended pH shocks and the ability to withstand oxygen and nutrient limitation are demonstrated. U.S.A.

## 95-0661

**Differential elimination of enteric bacteria by protists in a fresh water system.**

I. JIRIBERRI (Universidad del Pais Vasco, Bilbao), I. AZUAGA, I. LABIRU, A. ITURBURU, I. ARTOLOZAGA and I. BARCINA. *Journal of Applied Bacteriology*, 1994, 77, No 5, 476-483. The elimination of 5 enteric bacteria (*Klebsiella pneumoniae*, *Aeromonas hydrophila*, *Escherichia coli*, *Enterococcus faecalis* and *Staphylococcus epidermidis*) at both high and low densities in river water by flagellate and ciliate protists, was examined in the short and long-term (1 h and 3 d, respectively). The results suggest that there is an order of priority in the elimination of the 5 enteric bacteria by bacterivorous protists. Thus, in the long-term experiments carried out with high initial densities, the elimination efficiencies varied from 15 per cent for *E. faecalis* to 86 per cent *A. hydrophila*. The corresponding values for short-term, low-density experiments were 0.48 per cent for *E. faecalis* and 0.71 per cent for *E. coli*. It is assumed that the differences in the 2 orders of priority in elimination may be explained in terms of an analysis of the protistan digestion rates. There are 44 references. Spain.

## 95-0662

**Comparison of different homogenization procedures for detecting *Campylobacter* spp. in sewage sludge**

C. HOFFER (Kiel University) and U. SCHOMAKERS RIVAKA. *Journal of Applied Bacteriology*, 1994, 77, No 5, 591-596. Since large variations in the *Campylobacter* spp. count occur in municipal sewage sludge, attempts were made to improve the detection method by homogenizing seeded sewage sludge samples using 3 methods: high speed blender, ultrasonic bath and ultrasonic burst. In all cases, the recovery rate was less than 10 per cent. Other techniques were applied in an attempt to improve the position, and these included increasing the homogenization periods and frequencies, and filtration, pre-enrichment in a non-selective broth and supplementation with 1 per cent. None of these methods proved satisfactory, such that the bacterial counts always varied greatly, with the minimal and maximal values varying by at least 2 orders of magnitude. Germany.

## 95-0663

**A PCR assay for the detection of *Campylobacter jejuni* and *Campylobacter coli* in water.**

R. KIRK (Department of Agriculture, for Northern Ireland, Belfast) and M. T. ROWE. *Letters in Applied Microbiology*, 1994, 19, No 5, 303-303. A 20 ml sample of water containing *Campylobacter* was filtered through a 0.4 µm polycarbonate membrane which was then placed in a polymerase chain reaction (PCR) tube and sonicated to release the cells. The filter was removed from the cell suspension which was then subjected to a freeze/thaw cell lysis step. A semi-nested PCR was carried out on the filtrate using the primers CFO2, CFO3 and CFO4. A theoretical sensitivity of 10-20 cells per ml was achieved

with a 20 ml sample; this could be increased to around 2 cells per ml for a 100 ml sample. U.K.

## 95-0664

**Duplicate split samples for internal quality control in routine water microbiology**

N. T. LIGHTFOOT (Newcastle General Hospital), H. T. PELLETI, P. BOYD and S. EATON. *Letters in Applied Microbiology*, 1994, 19, No 5, 321-324.

The value of split samples in the quality control of water microbiology was evaluated on samples expected to contain 1-100 organisms per ml. Total coliforms and *Escherichia coli* were measured. Control charts were constructed with 95 per cent confidence intervals calculated on the basis of binomial theory. At one laboratory, 3 pairs in 50 were outside the confidence intervals compared with an expected 2.5; at another laboratory the number outside limits was 2. The approach was a useful internal quality control procedure. Excessive numbers of pairs outside limits or clusters should prompt an examination of procedures. U.K.

## 95-0665

**Evaluation of C-11-C agar, a modified mFC agar for the simultaneous enumeration of faecal coliforms and *Escherichia coli* in water samples.**

M. HERMINE (Laboratorio Cantonale, Lugano), I. DOMINICONE and M. TAGGI. *Letters in Applied Microbiology*, 1994, 19, No 5, 332-335.

A new medium for faecal organism enumeration was a modification of m-faecal coliform agar from which amline blue and lactose had been omitted. In their place, 4-methylumbelliferyl beta-D-glucuronide, 5-bromo-4-chloro-3-indolyl beta-D-galactopyranoside and isopropyl beta-D-thiogalactoside had been added. At 44°C, *Escherichia coli* gave blue-green colonies that fluoresced under UV light at 360 nm and became reddish violet when Kovacs' reagent was placed on the membrane. Faecal coliform did not fluoresce under similar conditions. Repair of sub-lethally injured cells by 4 h incubation at 50°C on tryptic soy agar increased recovery. Switzerland.

## 95-0666

**Faecal pollution events reconstructed and sources identified using a sediment bag grid**

P. G. NELSON Consultants Ltd, North Vancouver, B.C.), M. M. DZUKIN and K. L. MEKAS. *Water Environment Research*, 1994, 66, No 6, 813-818. Conventional microbiological surveys, relying on periodic sampling of the water column were unable to determine the source of faecal pollution at Panorama beach, North Vancouver, B.C., Canada. A novel sampling strategy was used in which sediment bags were arranged in a grid around the beach to reconstruct the contaminant plume at the beach and to determine the pollution source. The sand in the sediment bags accumulated faecal bacteria and retained them long enough so that they could be analysed during weekly surveys. This analysis indicated that the principal contaminant source was storm sewers. Canada.

## MONITORING AND ANALYSIS

95-0667

### Interactions between subsurface microbial assemblages and mixed organic and inorganic contaminant systems

H. M. HWANG (Jackson State University, Miss.), J. A. LOYA D. L. PERRY and R. SCHOLZE

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 5, 771-778

The microbial degradative activity in groundwater of a chemical waste landfill site in Georgia, U.S.A. and in groundwater samples from California was studied. Bacterial numbers, microbial utilization of naturally occurring compounds (e.g. glucose) and kinetics of microbial mineralization of model pollutants (p-cresol, toluene) were determined. The effects of inorganic nutrients on microbial degradation of toluene, p-cresol and phenol in groundwater were evaluated. Copper and imidazole enhanced bacterial heterotrophic activities by 61 per cent at substrate concentrations below 1  $\mu$ M. Bacterial activity was completely inhibited by 100  $\mu$ M copper. After exposure to different pH treatments for 17 h, bacterial mineralization of glucose in the California contaminated groundwater (pH 6.9) was inhibited by 31.5 per cent and 1.5 per cent at pH 4.6 and 8.4, respectively. Microbial degradation of p-cresol in the landfill was unaffected by additions of nitrogen and phosphorus indicating that nitrogen and phosphorus were not limiting. Addition of nitrogen, phosphorus and potassium to the California groundwater caused increases in phenol mineralization activity. U.S.A.

95-0668

### Bioremediation of phenolic compounds from water with plant root surface peroxidases

P. R. ADLER (USDA ARS, Kearneysville, W. Va.), R. ARORA, A. elGHIAOUTH, D. M. GLENN and J. M. SOLAR

*Journal of Environmental Quality*, 1994, 23, No 5, 1113-1117

The potential role of root surface proteins in the bioremediation of organic pollutants from the environment was studied. Plant peroxidases have been shown to polymerize phenolic compounds, removing them from solution by precipitation. Waterhyacinth (*Eichhornia crassipes*) and tomato (*Lycopersicon esculentum*) were tested for *in vitro* and *in vivo* root surface peroxidase activity. The peroxidase extracted from tomato and waterhyacinth plants polymerized guaiacol at the rate of 181 and 78 nmol tetraguaiacol formed per minute g root fresh weight, respectively. Peroxidase was distributed evenly on tomato root surfaces and patchily on waterhyacinth root surfaces. *In vitro* studies showed that the efficiency of peroxidase to polymerize phenols varied with phenolic compound. U.S.A.

95-0669

### Degradation of phenanthrene and pyrene by micro-organisms isolated from marine sediment and seawater

W. R. CUTTEN (British Columbia University, Vancouver), A. L. LI and K. J. REIMER

*Science of the Total Environment*, 1994, 156, No 1, 27-37

Kitimat Arm, B.C., Canada was contaminated with PAH from a local aluminium smelter. Micro-organisms that were able to degrade phenanthrene and pyrene were isolated from both seawater and sediment samples collected from Kitimat Arm using culture enrichment techniques. No additional PAH induction was necessary in the enrichment process, indicating that the PAH-degrading strains had been previously exposed to the PAH compounds. Four strains were isolated from a seawater culture. They were all Gram-negative and rod-shaped. Two were identified as *Moraxella atlantiae* and *Altero-*

*monas haloplanktis*. The other 2 belonged to the *Comamonas* genus and *Enterobacter* genus, respectively. There are 39 references. Canada

95-0670

### Biological alternatives to chemical identification for the ecotoxicological assessment of industrial effluents: the RTG-2 *in vitro* cytotoxicity test

A. CASTAÑO (Instituto Carlos III, Madrid), M. VEGA, T. BLAZQUEZ and J. V. TARAZONA

*Environmental Toxicology and Chemistry*, 1994, 13, No 10, 1607-1611

A fish cell line, RTG-2, was used in the development of an *in vitro* cytology procedure for examining toxic effects in chemically fractionated complex aqueous effluents. The test avoided the low yield constraints that high resolution chemical separation had for toxicity-based tests. Ecotoxicological assessment was possible without identification of the chemical species involved. The test was used to evaluate the performance of an aeronautics industry effluent treatment plant and to establish a link between effluent discharge from a fish processing plant and uptake in fish and molluscs in Esteiro bay, Spain. The tests proved that toxicological components from the aeronautics effluent were eliminated successfully by the treatment process and that toxic chemicals from the fish processing effluent had accumulated in fish and molluscs in the Esteiro bay, without the need to identify the chemicals. Spain

95-0671

### Extensive butyltin contamination in southwestern coastal British Columbia, Canada

C. STEWART (Institute of Ocean Sciences, Sidney, B.C.) and J. A. J. THOMPSON

*Marine Pollution Bulletin*, 1994, 28, No 10, 601-606

Fish, shellfish or sediment samples from 10 sites in south western British Columbia were analysed for butyltin, phenyltin and cyclohexyltin compounds. No cyclohexyltin or phenyltin compounds were detected. All coastal and Fraser river samples contained tributyltin (TBT), usually with its metabolites, but sediment samples from another creek did not. TBT, dibutyltin and monobutyltin were all found in a benthic sediment core from a deep sedimentary basin with a water depth of 377 m, but concentrations only decreased slightly with core depth. Butyltin contamination was still widespread despite restrictions on the use of organotin anti-fouling paints. There are 41 references. Canada

95-0672

### Use of rat brain sodium, potassium-ATPase assay to determine effectiveness of biological treatment to reduce toxicity of paper mill effluents

J. S. ARAUJO NETO (Universidade Federal do Rio de Janeiro), A. J. MARTINS and G. I. SANTANNA

*Water Research*, 1994, 28, No 12, 2583-2584

The toxicity of bleached pulp and paper mill wastewaters was assessed by the degree of inhibition of the enzyme sodium, potassium ATPase isolated from rat brain microsomal fraction. The amount of adenosine triphosphate (ATP) hydrolysed to phosphate after 10 minutes in the presence of the effluent and enzyme was taken as a measure of inhibition. This was considerable for untreated effluent but was reduced almost to zero after wastewater treatment with the fungus *Phanerochaete chrysosporium*. Brazil

95-0673

**Mercury and selenium localization in macrophages of the striped dolphin, *Stenella coeruleoalba*.**

M. NIGRO (Dipartimento di Biomedicina Sperimentale, Pisa)  
*Journal of Marine Biological Association*, 1994, 74, No 4, 975-978

Using transmission electron microscopy and X-ray microprobe analysis, mercury and selenium accumulation in striped dolphin *Stenella coeruleoalba*, was shown as dense intracellular granules located principally within the liver macrophages (Kupffer cells). Granules having 150 Angstrom spherical particles showed the same electron diffraction pattern and X-ray spectrum as mercuric selenide. The role of macrophages in mercuric selenide granule production and storage is discussed. **Italy**

95-0674

**Detection of butyltin compound residues in the blubber of marine animals.**

H. IWATA (Ehime University, Matsuyama), S. TANABE, N. MIYAZAKI and R. TATSUKAWA

*Marine Pollution Bulletin*, 1994, 28, No 10, 607-612

Blubber samples from 8 species of marine mammals, caught around Japan or in the North Pacific Indian and Antarctic oceans, were analysed for butyltin compounds (BTC). BTC were detected in all the animals except a minke whale from the Antarctic ocean. The highest total concentration (770 ng per g wet weight) was found in a finless porpoise from the Seto inland sea, Japan. Concentrations were lower in those specimens caught in the open sea than in those from coastal waters. The finless porpoises had a lower proportion of dibutyltin and more monobutyltin than have been reported in most fish and shellfish species. This accumulation pattern may be due to their specific metabolic capacity. **Japan**

95-0675

**Bioconcentration of chlorpyrifos by the three-spined stickleback under laboratory and field conditions.**

T. W. DENEER (DLO Winand Staring Centre for Integrated Land Soil and Water Research (SC-DLO), Wageningen)  
*Chemosphere*, 1994, 29, No 7, 1561-1575

The feasibility of predicting the concentration of the organophosphorus insecticide chlorpyrifos in fish in outdoor mesocosms using uptake and elimination rate constants determined in the laboratory was investigated. Three-spined stickleback (*Gasterosteus aculeatus*) were exposed to the insecticide in the laboratory and 3 outdoor ditches at exposure levels of 0.25 and 0.1-6 µg per litre, respectively. The lipid-based bioconcentration factor, and uptake and elimination rate coefficients were calculated. Uptake and elimination were described using a first-order one-compartment kinetic model. Chlorpyrifos concentrations observed in sticklebacks were higher than those calculated using the laboratory-derived data. First-order one-compartment models, derived from uptake and elimination rate coefficients, for the prediction of residues of chlorpyrifos in sticklebacks should be limited to concentrations far below the LC50. There are 32 references. **Netherlands**

95-0676

**Responses of electric fish (family Mormyridae) to chemical changes in water quality: III. Heavy metals.**

J. W. LEWIS (London University, Egham), A. N. KAY and N. S. HANNA

*Environmental Technology*, 1994, 15, No 10, 969-978

Varying concentrations of 3 heavy metals (cadmium, chromium and copper) were used to study the effects on the pulse rate of 2 fish species (*Gnathonemus petersi* and *Gnathonemus nanaeus*). The response was in the form of a modification of the electric organ discharge activity, and although the response pattern was variable, both species were sensitive to 100-200 µg cadmium per litre, 5.0 µg hexavalent and trivalent chromium per litre, and 5.0 µg to 0.1 mg copper per litre. Overall, there is evidence that these fish are sensitive to heavy metal pollution in water, and it is anticipated that there could be further improvements in sensitivity as a function of refinements in the electronic design of the current system. **UK**

95-0677

**Uptake and release kinetics of caesium-134 by goldfish (*Carassius auratus*) and caesium-137 by zebra fish (*Brachydanio rerio*) in controlled aquatic environment.**

A. SRIVASTAVA (Oregon State University, Corvallis), S. J. REDDY, O. KELLER, K. URICH and H. O. DENSCHEIG  
*Journal of Radioanalytical and Nuclear Chemistry*, 1994, 182, No 1, 63-69

The influence of the temperature and ionic composition of aquatic media on the uptake and release kinetics of radioactive caesium was investigated. The uptake and release of caesium-134 by goldfish (*Carassius auratus*) and caesium-137 by zebra fish (*Brachydanio rerio*) were examined in controlled laboratory conditions. In the case of *B. rerio*, caesium accumulation was strongly dependent on the potassium ion concentration of the medium, while there was only a weak dependence in the case of *C. auratus*. The biological half-lives of the isotopes incorporated ranged from 19 to 80 d and were affected by the temperature and ionic composition of the aquatic medium. **U.S.A.**

95-0678

**Effects of pH on the bioconcentration of pyrene in the larval midge, *Chironomus riparius*.**

T. WHITT (Universität Basel), R. NAGEL and C. F. W. STEINBERG

*Water Research*, 1994, 28, No 12, 2553-2559

Bioconcentration, depuration and biotransformation of carbon-14 labelled pyrene were studied at pH 4, 6 and 8 in the larval stages of the chironomid midge *Chironomus riparius* under laboratory conditions. Larvae were exposed to 1-3 µg pyrene per litre in the bioconcentration and biotransformation experiments. Metabolites were examined by thin layer chromatography. Pyrene recovery was assessed by measuring carbon-14. Bioconcentration and depuration data were fitted by 1-compartment and 2-compartment models, respectively. All processes were pH-dependent; decreasing pH resulted in lower bioconcentration and depuration rates, and smaller bioconcentration factors. The compartments in the kinetic models were also smaller at low pH. Increased mucus production in acid waters probably generated a significant diffusion barrier, which explained these observations. **Switzerland**

## MONITORING AND ANALYSIS

95-0679

### Accumulation of cadmium associated with sewage sludge by a marine amphipod crustacean.

M. F. C. APARIS (London University) and P. S. RAINBOW  
*Science of the Total Environment* 1994, 156, No 3, 191-198

Experimental work investigating the accumulation of sludge-associated cadmium by *Corophium volutator* is described. It accumulated labelled cadmium in proportion to the duration of exposure and the cadmium concentration of the sludge. Newly accumulated cadmium was added to the existing cadmium body load without significant excretion of any original body cadmium. *C. volutator* accumulated cadmium without significant mortality at concentrations higher than those documented for sewage contaminated British sediments (up to 26.75 µg added cadmium per g). The significance of the results is discussed. U.K.

95-0680

### Involvement of metallothionein in cadmium accumulation and elimination in the clam *Ruditapes decussata*.

M. J. BEBIANNO (Algarve University, Faro) M. A. P. SERRAÍM and M. T. RITA

*Bulletin of Environmental Contamination and Toxicology* 1994, 53, No 5, 726-732

The involvement of metallothionein synthesis in cadmium accumulation and elimination in the bivalve *Ruditapes decussata* was investigated when the bivalve was exposed to a sublethal cadmium concentration (100 µg per litre) and to a mixture of cadmium (100 µg per litre), copper (50 µg per litre) and zinc (50 µg per litre). Cadmium contents of clams were analysed after 7-30 d exposure. Cadmium increased in treated clams during 30 d exposure. The cadmium accumulation rate was greatest in the digestive gland (5.8 µg per g d) followed by the gills (3.6 µg per g d) and the remaining tissues (1.2 µg per g d). The concentration of cadmium in the digestive gland exceeded that in the gills but only after 14 d of exposure, suggesting that the cadmium in the gills was transported to the digestive gland for storage. The cadmium accumulation pattern of clams exposed to cadmium plus copper and zinc was similar to that of clams exposed to cadmium only. The final concentrations of cadmium in the tissues of clams exposed to the metal mixture were higher except in the remaining tissues than those treated only with cadmium. During depuration cadmium loss was very slow. Metallothionein levels increased in cadmium exposed clams and decreased during depuration. Portugal

95-0681

### Elimination of polychlorinated dibenzofurans and dibenzo-p-dioxins from blue mussel (*Mytilus edulis*) and tissue distribution of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)

H. H. KJØLN (Norwegian Institute for Water Research, Oslo) J. A. BERGL, K. INGEBRIGTSEN, J. KNUTZÉN and M. ØIHIM

*Chemosphere* 1994, 29, No 7, 1491-1499

The uptake, elimination and distribution of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in blue mussels (*Mytilus edulis*) exposed to contaminated sediment were studied. The distribution pattern of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) was studied by whole body autoradiography. Samples of mussels exposed to carbon-14 labelled 2,3,7,8-TCDD were taken after 14 and 21 d and hepatopancreas, gills, foot and mantle were prepared for liquid scintillation counting. Autoradiograms of mussels at day 1 showed that the radiolabelled substance was principally present in the hepatopancreas with

smaller amounts in the gills and foot. The concentration expressed as 2,3,7,8-TE, in the mussels exposed to water from the contaminated sediment tank increased from 1.61 pg per g to 124.6 pg per g during 90 d. Levels of tetra- and pentachlorinated congeners increased during the exposure period. Some hexa-, hepta-, and pentachlorinated congeners reached a steady state concentration after 15 d. Assuming first order kinetics, the half-lives of selected 2,3,7,8-chlorosubstituted PCDF/PCDD congeners were 18-58 d. Norway

95-0682

### Organic halogen compounds, EOX, in mussels from a clean lake and a pulp mill recipient.

J. PELINEN (Joensuu University) M. RUOKOLAINEN, P. MÄKILÄ and J. TASKINEN

*Chemosphere* 1994, 29, No 7, 1515-1526

Mussels (*Anodonta anatina* and *Pseudanodonta complanata*) were collected from an uncontaminated lake (Hoytiainen lake) and some were incubated in a lake receiving pulp mill effluent (Saimaa lake) in Finland. The extractable organic halogen (EOX) content of both species was determined. There was no statistically significant difference in the EOX residues on a lipid normalized basis between the 2 species although the residue of *A. anatina* was 14 per cent higher than that of *P. complanata*. The EOX concentration in *A. anatina* in the unpolluted and polluted lakes were 690 and 2045 µg per g of lipids, respectively. The composition of the EOX in mussels remained largely undefined with chlorinated fatty acids contributing the greatest concentration of known compound classes. Atmospheric deposition combined with biogenic synthesis might be an additional source of EOX. No difference was found in EOX content between male and female mussels but mussels infected by a digenaeid parasite had higher EOX concentrations than healthy females. Finland

95-0683

### Bioaccumulation of chemical markers as a means for the field detection and verification of organophosphorus warfare agents.

J. B. TERRARIO (New Orleans University) L. F. R. DEL LON and L. A. PEULER

*Environmental Science & Technology* 1994, 28, No 11, 1893-1897

The viability of a detection and verification technique that used the brackish water clam *Rangia cuneata* as a bioaccumulator of marker compounds associated with 2 chemical warfare agents (CWA) was studied. The CWA were nerve agents VX and GB/Sarin. Two trace components identified in both clam tissue and the standards of VX and GB were selected as marker compounds for the bioaccumulation study. Diethyl S-ethylmethylphosphonothiolate (DEMPT) derived from VX and diisopropylmethylphosphonate (DIMP) derived from GB/Sarin. The bioaccumulation of the marker compounds was measured using high resolution GC and high resolution GC/MS. The clam accumulated DEMPT to an average level of 2500 pph when exposed to a water concentration of 100 pph of DEMPT during the 5 week bioaccumulation study. The clams accumulated 2700 pph DIMP when exposed to 100 pph DIMP for 6 d. A biomonitoring approach for the detection and verification of organophosphorus warfare agents was a viable alternative to conventional methods of analysis. U.S.A.

95-0684

**Accumulation and subcellular distribution of metals (Cu, Fe, Mn, Pd and Zn) in the Mediterranean mussel *Mytilus gallo-provincialis* during a field transplant experiment.**F. REGOLLI (Università di Pisa), and E. ORLANDO  
*Marine Pollution Bulletin*, 1994, 28, No 10, 592-600

Mussels were transplanted from a marine farm to a heavy metal polluted environment, and native mussels from both environments were transferred to a depuration system. The concentrations of metals in the digestive glands and metal distribution in the subcellular fractions were measured. Iron, manganese and lead were rapidly accumulated by mussels transplanted to the polluted environment and were at steady state concentration within 2 weeks. No significant accumulation of copper and zinc occurred. There was a loss of manganese from depurating farm mussels in the first 2 weeks, but no other concentration changes. Depurating mussels from the polluted environment showed a fall in manganese concentration during the first week, then a further fall after 2 months. Iron excretion was also rapid, but lead concentrations remained high during the 5 month depuration period. The distribution pattern was different for each element, but did not vary with the source of the mussels or the season. There are 49 references. Italy.

95-0685

**Comparative study of two in vitro models (L-929 fibroblasts and *Tetrahymena pyriformis* GL) for the cytotoxicological evaluation of packaged water.**M. P. SAUVANT (Faculté de Pharmacie, Clermont-Ferrand), D. PÉPIN, J. BOHATIER, C. A. GROLIÉRE and A. VEYRE  
*Science of the Total Environment*, 1994, 156, No 2, 159-167

The leaching of chemicals from 234 water samples in glass, polyvinyl chloride and polyethylene terephthalate bottles was investigated by chemical analysis and *in vitro* toxicological bioassays. Water samples were evaluated every 3 months for a maximum of 36 months. Metals were measured by atomic absorption spectrophotometry, vinyl chloride and acetaldehyde by gas chromatography. Toxicological determinations were made on the L-929 established cell line of fibroblasts using several bioassays. Tests were also performed on the dynamic growth and cell proliferation of *Tetrahymena pyriformis* GL. Results were analysed by non-parametric 2-way statistics. The chemical analyses suggested that no undesirable substances leached into the water. However, some samples showed toxicity after 18 months whatever the composition of the bottle. Statistical analysis failed to reveal a mathematical relationship between cytotoxic effects, the length of storage and the packaging. There are 30 references. France.

95-0686

**The bioavailability of copper in wastewater to *Lemna minor* with biological and electrochemical measures of complexation.**J. A. BUCKLEY (Washington University, Seattle)  
*Water Research*, 1994, 28, No 12, 2457-2467

The relationship between complexation and bioavailability of copper was studied by growing duckweed *Lemna minor* in 0.45 µm-filtered domestic wastewater containing copper sulphate. Six plants were grown in each solution at pH 7 and 25°C for 24 h in light, then transferred to fresh solutions. Duckweed samples were digested in nitric acid and its copper content analysed by inductively coupled plasma atomic absorption spectrometry. Copper(II) ion concentration was measured in solution by ion selective electrode. Copper complexing capacity was measured electrochemically and biologically, in the latter the estimate was made from the no observed

effect concentration and those levels causing a 5 and 50 per cent response in the organism. Growth was not inhibited until total copper exceeded 0.079-0.119 mg per litre. Copper(II) was detectable when total copper was 0.4 mg per litre. There was a significant relationship between copper bioconcentration and total copper in wastewater. There was some indication that some complexes in the wastewater were bioavailable in addition to copper(II). Copper complexing ability was measured as 0.26-0.29 and 0.077-0.125 mg per litre from non selective and biological methods respectively, the latter being 2-3 times more sensitive. There are 47 references. U.S.A.

95-0687

**Bioaccumulation of metals by *Scenedesmus*, *Selenastrum* and *Chlorella* algae.**D. BRADY (Rhodes University, Grahamstown), B. LITTEBELLE, J. R. DUNCAN and P. D. ROSE  
*Water SA*, 1994, 20, No 3, 213-218

Three freshwater algal species (*Scenedesmus*, *Selenastrum* and *Chlorella*) accumulated copper(II), lead(II) and chromium(III) cations from solutions with approximately 90 per cent efficiency for initial metal concentrations varying by almost 2 degrees of magnitude. *Chlorella* was the least efficient accumulator of these cations but accumulated greater quantities of dichromate ions than the other organisms. Chromium(III) accumulation from tannery effluent was much less than from the artificial solutions, reaching a maximum of only 39 per cent, possibly due to binding competition with organics or the oxidation of chromium to chromate. Of the metals studied, a high concentration of copper(II) was the most toxic. South Africa.

95-0688

**Intrinsically safe samplers minimize risk of sewer explosions.**

C. KIRKPATRICK (Montec International Limited, Manchester, U.K.)

*Water & Wastewater International*, 1994, 9, No 5, 29-30

The development of a safe portable sampler for hazardous sewer sampling is reported. Four separate motors maintained individual power ratings below safe maxima, and 10 separate control circuits were isolated from each other. Other components were certified intrinsically safe (IS) or were manufactured to conform to IS specifications. U.S.A.

95-0689

**Modelling concentration variations in high-capacity wells: implications for groundwater sampling.**

D. C. GOSSIELN (Nebraska Lincoln University), J. E. AYERS and Y. K. ZHANG

*Water Resources Bulletin*, 1994, 30, No 4, 613-622

The limitation of water quality sampling from high capacity wells was examined using a semi-analytical particle tracking model to investigate the effect of variable vertical contamination and aquifer anisotropy on water sample composition over short pumping periods. The hypothetical well used in the model was located in an unconfined alluvial aquifer with a shallow water table and concentration gradients of nitrate nitrogen. Groundwater contamination was underestimated by samples from high capacity wells. The profiles of concentration time curves for such wells were principally influenced by contaminant distribution and travel time to the well and that well design, pumping rate and hydrogeological properties influenced the magnitude of these curves. The sampling strategy for high capacity wells should use concentration curves based on well characteristics rather than individual samples to give better interpretation of spatial contaminant distribution. U.S.A.

## MONITORING AND ANALYSIS

95-0690

### Flow injection techniques for water monitoring.

K. N. ANDREW (Plymouth University), N. J. BLUNDELL, D. PRICE, and P. J. WORSFOLD

*Analytical Chemistry*, 1994, **66**, No 18, 916A-922A

The features of flow-injection (FI) that made it so attractive for laboratory and process analysis are highlighted and the ways in which these characteristics were applicable to monitoring natural and polluted waters are discussed. On-site automated FI monitors were thought to provide near-continuous, reliable and low-cost data for assessing water quality. One of the most promising new applications of FI was seen to be its use for front end sample treatment and delivery for spectroscopic detection (e.g. ICP-MS). This review of FI applications includes process applications in the areas of chemical production, metal production, paper production, fish farming, hydroponic cultivation, wastewater monitoring, water treatment monitoring and biotechnology. Environmental monitoring (*in situ*) applications in freshwater, marine and groundwater situations include the analysis of nitrate, nitrite, ammonia, hydrogen peroxide, cobalt, manganese, silicate, copper, iron, phosphate and sulphate. There are 40 references. U.K.

95-0691

### Why carry out decentralized internal monitoring for bacteriological quality in drinking water distribution systems?

G. RIGAUD (Anjou Recherche), G. RANDON, D. GATHI, J. I. GAGNON, and M. DUTANG

*L'au Industrielle Nuisances*, 1994, No 176, 54-57 (in French, English summary)

In parallel with the inspection and monitoring programme of the Public Health Department, the Campagne Generale des Eaux had set up its own system of remote bacteriological monitoring of drinking water quality. This was based on a network of strategically located analysers capable of performing large numbers of bacterial assays to determine the levels of *Escherichia coli* and faecal coliforms in the samples provided. Each of these automated analysers covered a specific geographical area representing several dozen sampling points. They could be used by people with broad technical capability rather than specialized technicians and did not require the services of a fully equipped laboratory for bacteriological analyses. The data obtained from their operation could be analysed at a central processing station to determine any evidence of real time contamination in a specific part of the network and to develop possible correlations between bacteriological quality, the hydraulic behaviour of the network and its variation with time. (English translation 145 pounds sterling, valid for 1995) France

95-0692

### A statistician's view of the U.S. Primary Drinking Water Regulation on coliform contamination.

M. A. HAMILLTON (Montana State University, Bozeman)

*Environmental Science & Technology*, 1994, **28**, No 11, 1808-1811

In 1989 the U.S. EPA published new regulations for monitoring drinking water for total coliform contamination. Under the new rules, 100 ml samples were assayed for coliform presence. If they were present in a small proportion of samples (usually 5 per cent or less) the water system was in compliance. Statistical analyses of the compliance criteria are presented. The regulations specified a compliance criterion in terms of a maximal contaminant level, specify a protection reliability standard, define a compliance rule, and calcu-

lated the false pass and false fail rate. Statistical analysis of the compliance criterion shows that the false pass rate and/or the protection reliability standard were higher than intended. U.S.A.

95-0693

### Sample filtration for on-line analytical determinations in sewage treatment plants.

W. SCHULZ (ATZ-EVUS, Sulzbach-Rosenberg), and S. KOHLER

*Gas Wasser Abwasser*, 1994, **74**, No 9, 748-753 (in German, English summary)

The reliable operation of on-line sensors for a number of analytical parameters required a sample stream from which particles larger than 1 µm were eliminated. The methods currently employed for this are based on the use of crossflow ultrafiltration and require a feed rate to the filter unit of up to 12 m³ per h, such a large rate of flow causes problems including high running costs and space requirements. A more economical and compact system of sample pretreatment is described, termed pulsed crossflow microfiltration. A special tubular test rig was devised which incorporated a tough capillary membrane capable of withstanding the pulsating pressure, controlled by a spring loaded valve on the outlet. Based on the successful results obtained using sample flows drawn from different parts of the sewage treatment system, a prototype operating unit was constructed and tested in various positions. The feed rate of 100 litres per h allowed a very compact design, with built-in cleaning ports. During a 6 week trial at a south German sewage works, the filtrate flow obtained from the trickling filter effluent stream was adequate for the demands of an on-line phosphate measuring instrument. The intervals between cleaning were at least equal to and mostly greater than those for alternative commercial pretreatment systems. (English translation 150 pounds sterling, valid for 1995) Germany

95-0694

### Groundwater monitoring systems and groundwater quality in the Detmold administrative district (North Rhine-Westphalia).

J. GRABAU

*Wasserwirtschaft*, 1994, **84**, No 9, 468-476 (in German, English summary)

The operation of groundwater quality monitoring systems for the Detmold region under the control of the Minden Water and Waste Disposal Office of the provincial administration is reviewed and contrasted with the system of routine drinking water quality monitoring covering piped supplies and private wells, for the town of Bielefeld. In the case of the regional network even the existence of relatively large numbers of observation wells (1700 for the whole of North Rhine-Westphalia) did not permit a thorough categorization of groundwater resources throughout the area and in the absence of more information concerning groundwater flow, the 462 observation sites surveyed merely constituted a series of point observations. More detailed groundwater mapping was possible as a result of sampling and analysis from a network of 700 private wells in the vicinity of Bielefeld and the results were subjected to a series of statistical interpretations including values from around 2000 groundwater observation wells. Values could be amplified using the geostatistical kriging technique for interpolation and contour maps or isolines could be plotted for specific constituents such as nitrate to demonstrate the variability of groundwater composition in space. (English translation 370 pounds sterling, valid for 1995)

Germany

95-0695

**Economics of screening for pesticides in ground water.**

C. NATARAJAN (North Carolina-Greensboro University) and R. RAJAGOPAL

*Water Resources Bulletin*, 1994, 30, No 4, 579-588

The U.S.A. monitored source water quality by using a suite of organic determinands. Prioritizing the organic compounds likely to occur in a catchment would reduce the size of the monitoring programme. Sequential analysis and sample composting were used in the preparation of monitoring strategies for a state-sized operation and the relative economics evaluated. Using this scheme to identify contaminated sources amongst 4000 wells gave an analytical cost of between 12,500 and 1,575,000 U.S. dollars, dependent on the level of contamination. The cost of the conventional programme was 1,000,000 U.S. dollars. It was economically viable to consider alternative monitoring strategies from the conventional approach to source monitoring. U.S.A.

95-0696

**Mobile venturi duct with a rectangular profile**

J. FEBER (ETH Zentrum Zurich) and W. H. HAGLER

*Umwelt Wasser Abwasser*, 1994, 74, No 9, 761-768 (in German; English summary)

The behaviour of the so-called mobile venturi duct was tested under laboratory conditions to obtain a series of curves relating the variables of input flow rate, channel width and obstruction ratio. The moveable element consisted of a cylinder positioned vertically in a rectangular flume so that a constriction occurred, with flow directed along the walls of the flume rather than along the centre of the channel as in the case of the standard type of venturi. The system could be used as a flow measurement device by drilling holes in the wall of the cylinder when the level of water in the cylinder could be related to the flow in the channel. The cylinder diameter should be between 50 per cent and 60 per cent of the width of the channel. The position of the cylinder relative to the axis of the channel was of secondary importance but the holes should be situated not more than 10 degrees away from the axial direction. There was only moderate sensitivity to back up in the tailwater zone. (English translation 215 pounds sterling, valid for 1995). Switzerland

95-0697

**A simple, inexpensive rain and canopy throughfall collector**

R. GILAUD (USDA Forest Service, Riverside, Calif.) and A. GOMELZ

*Journal of Environmental Quality*, 1994, 23, No 5, 1103-1107

A low-cost field collector for collecting rain and canopy throughfall samples for volume and ion analyses is described. The collector was made of wood and plastic and remained covered until the rain began preventing the collection of dry deposition, dust and insects. The trigger consisted of a weighted counter balanced cover that was held in place by a piece of water-soluble paper. When the paper dissolved the counter-weight pulled the cover away from the collector opening, allowing rain to be collected. The construction, installation, laboratory studies and field trials of the collector are described. Laboratory tests showed that the collector would trigger within the first 0.37 mm depth of rain (95 per cent probability). U.S.A.

95-0698

**Infrared analysis cost-effective with new detector; says Dräger.**

B. DILLIG (Drägerwerk Aktiengesellschaft, Lübeck)

*Water & Wastewater International*, 1994, 9, No 5, 39-40

Development is reported of an infrared chemical detector comprising a low-voltage incandescent source in a flameproof enclosure, a long-path measuring cell and a split-beam pyroelectric detector. The instrument was resistant to toxic substances, functioned in the absence of oxygen, was sensitive, provided unambiguous measurements, was not subject to ageing and was resistant to humidity. Applications in petroleum and water industries are briefly reported. Germany

95-0699

**The design and research potential of an artificial stream system for the investigation of macroinvertebrate water quality tolerances**

C. G. PALMER (Rhodes University, Grahamstown, W.S.)

ROWLSTON, W. A., JEZIEWSKI and P. ESKOJNICKY

*Water SA*, 1994, 20, No 3, 247-258

Artificial stream design alternatives are reviewed. An artificial stream system was designed and built at Rhodes University to accurately describe a range of hydraulic conditions. The design considerations, structure and components of the large 3-channel system are described. Small-scale models for use in the laboratory or in the field were constructed on a raceway design. The artificial stream laboratory provided flowing water recirculating systems for toxicity testing of indigenous riverine organisms. In addition to water quality research, the system could be used for investigating the hydraulic preferences of stream organisms. There are 49 references. South Africa

95-0700

**The drop-pattern method as a potential sum-of-parameters indicator of water quality. I. A pilot study in drinking-water production**

M. M. MATTHIJSEN (RIVM), J. D. van MANSVELT and H. A. M. de KRUIJF

*H2O*, 1994, 27, No 22, 634-647 and 660 (in Dutch; English summary, p. 643)

A method of characterizing water according to the pattern made by a drop of oil falling into a dish. Oiled-outlined waters having different characteristics (degree of contamination or purity) will exhibit different degrees of hydrophobic activity in the pattern formed by drops of them. A method for obtaining such a pattern is outlined, about 30 drops of distilled water are fed onto a Petri dish (an optically clear bottom of 14 cm diameter). A sample of the water mixed with pyrene to a level of 11 per cent by volume and a drop of it allowed to fall from a standard height of 10 cm into the dish. The pattern of its spreading formed after a standard interval of 5 seconds is photographed from below the dish. Photographs of waters taken from different parts of the Amsterdam water supply system (distilled tap water, a spring source and a water immediately before dune infiltration) are included. (English translation 195 pounds sterling, valid for 1995). Netherlands



## MONITORING AND ANALYSIS

95-0701

### **Fast neutron activation analysis of Nga-Khu (*Clarias magur*) fresh-water fish.**

M. U. (Yangon University, Myanmar), and C. THAN  
*Journal of Radioanalytical and Nuclear Chemistry Letters* 1994  
188, No 1, 9-13

Sodium, phosphorus, potassium, calcium, chlorine, iron and magnesium in the freshwater fish *Clarias magur* were determined using fast neutron activation analysis, an established method for the determination of minerals in food. Edible and non edible portions of the fish were analysed after reduction of samples to dry ash. The technique adopted used 14 MeV neutrons from a Kaman A 710 neutron generator. The irradiation time was 10 minutes. The consecutive mode was used and counting was done sequentially. The dual aluminium foils technique was used for neutron flux monitoring. The results were in general agreement with those from atomic absorption spectrometry. **International**

95-0702

### **Hydrochloric acid.**

J. TILLEMANS (Solvay Benelux SA, Bruxelles), X. VAN KESTEREN and P. SMETS

*Tribune de l'Eau* 1994, 47, No 570, 3-7 (in French)

The physical and chemical properties of hydrochloric acid and the precautions to be observed when transporting, storing and transferring it at the point of use are reviewed, including a summary of remedial measures to be applied in the event of an accident. Methods of analysis, determination of impurities and the toxicological properties of hydrochloric acid, in particular its effects following inhalation, contact with skin and eyes and accidental injection are also outlined. (English translation 185 pounds sterling, valid for 1995)

**Belgium**

95-0703

### **Sulphuric acid.**

G. CRUCK (Metallurgie Hoboken Overpelt S.A., Bruxelles), P. SMETS and R. HUSSON

*Tribune de l'Eau* 1994, 47, No 570, 10-15 (in French)

The physical and chemical properties of sulphuric acid and its behaviour in contact with a variety of materials are outlined, followed by a specification and list of possible uses for the technically pure product. Methods of transporting and storing the acid and the precautions to be taken at all stages are described, including emergency measures following direct contact with the liquid. Methods of analyses and for determination of impurities, in particular metals, including mercury and arsenic, are briefly indicated and a brief summary of its toxicological effects is included. (English translation 220 pounds sterling, valid for 1995) **Belgium**

95-0704

### **Chlorine.**

M. FRANCOIS (SOLVAY Benelux SA, Bruxelles), and X. VAN KESTEREN

*Tribune de l'Eau* 1994, 47, No 570, 16-20 (in French)

The properties of chlorine in the liquid and gaseous forms are outlined, with a description of its application to the treatment and disinfection of water and effluents. The manner in which it is supplied, the precautions to be observed in storing and transferring it, and first aid treatment following an accident are summarized and methods of determination are also described. Its acute and chronic toxic effects are also discussed and a dose/response diagram showing the levels at which various symptoms occur on exposure for increas-

ing lengths of time is included. (English translation 185 pounds sterling, valid for 1995) **Belgium**

95-0705

### **Sodium chlorite.**

Y. DENUTTE (SOLVAY Interox SA, Bruxelles), and X. VAN KESTEREN

*Tribune de l'Eau* 1994, 47, No 570, 21-25 (in French)

The physical and chemical properties of sodium chlorite, its method of manufacture and commercially available forms are outlined, followed by an account of its utilization in the treatment of potable supplies, both for oxidation of trace organic contaminants and the disinfection of treated water. The methods of transport and precautions to be observed in storing and handling sodium chlorite solutions are reviewed, together with the remedial measures required in an emergency. Finally methods of analysis and identification are summarized and its physiological effects stated. (English translation 185 pounds sterling, valid for 1995) **Belgium**

95-0706

### **Ammonium chloride.**

P. SMETS (Tessenderlo Chemie SA)

*Tribune de l'Eau* 1994, 47, No 570, 26-29 (in French)

The properties, methods of manufacture and commercially available forms of ammonium chloride are summarized, together with a review of its application and methods of storage and handling prior to use in connection with disinfection of treated waters using chloramines prepared from chlorine and ammonium chloride. The various standard methods of analysis and the determination of metallic impurities are enumerated and a summary of physiological effects associated with skin contact, ingestion or inhalation is given. (English translation 150 pounds sterling, valid for 1995) **Belgium**

95-0707

### **Ferric chloride, 40 per cent solution.**

X. VAN KESTEREN (SOLVAY Benelux SA, Bruxelles), and P. SMETS

*Tribune de l'Eau* 1994, 47, No 570, 31-41 (in French)

The physical and chemical properties of the commercially available 40 per cent ferric chloride solution are reviewed, including its tendency to undergo hydrolysis with the formation of molecular polymers, and its function as a coagulant or a flocculating agent. The nature of the chemical impurities, methods for their determination and estimating of the proportions of ferric and ferrous chloride in the solution are described, and the mode of utilization of the product for treating potable supplies is outlined. Applications include the elimination of colloidal particles responsible for turbidity, coagulation of phosphates, and reductions in the level of COD and some heavy metals. Methods of transport and handling precautions to be observed and toxicological properties towards various organisms are summarized. (English translation 440 pounds sterling, valid for 1995) **Belgium**

95-0708

### **Sodium hydroxide.**

M. P. SMETS (Tessenderlo Chemie SA), and X. VAN KESTEREN

*Tribune de l'Eau* 1994, 47, No 570, 44-50 (in French)

The physical and chemical properties of sodium hydroxide (caustic soda), its manufacture, behaviour in solution and the nature of chemical impurities present in commercially available forms are reviewed, together with a description of its application in the treatment of

potable supplies. The methods of transport and handling, including precautions to be taken to prevent injury, are considered, and the methods of analysis and determination of foreign matter (silicate, iron, mercury, calcium and magnesium) are outlined. Values for acute oral toxicity in rabbits are listed. (English translation 230 pounds sterling, valid for 1995). **Belgium**

95-0709

**Sodium hypochlorite.**

P. SMEETS (Tessenderlo Chemie S.A. Bruxelles), A.

FRANCOIS and X. VAN KESTEREN

*Tribune de l'Eau*, 1994, 47, No 570, 51-56 (in French)

The properties of sodium hypochlorite and its commercially available forms are outlined, and its use as a disinfectant in the preparation and distribution of drinking water is described. The methods of storage and transport and the precautions to be observed are summarized, and a review of analytical methods for the determination of the product, in particular its chlorine content, and some possible impurities are reviewed. A brief summary of its toxicological properties with respect to man and animals and also aquatic organisms is included. (English translation 280 pounds sterling, valid for 1995). **Belgium**

95-0710

**Hydrogen peroxide.**

Y. DENUITE (SOLVAY Interox sa, Bruxelles) and X. VAN

KESTEREN

*Tribune de l'Eau*, 1994, 47, No 570, 57-61 (in French)

The physical and chemical properties of hydrogen peroxide, and the forms in which it is supplied commercially, are described, followed by an account of the precautions to be observed during storage and handling, with details of the materials with which it may be allowed to come into contact without harmful effects. It must be kept away from combustible materials and inflammable organic compounds. Methods of analysis for the product are described, including volumetric method and 2 titrimetric procedures, one of which is designed for use with bleaching solutions containing small amounts of organic matter. (English translation 165 pounds sterling, valid for 1995). **Belgium**

95-0711

**Hydrated lime - LHOCAI - EH63 (ALPHA 63).**

*Tribune de l'Eau*, 1994, 47, No 570, 62-63 (in French)

The properties of this form of hydrated lime, which consists of a fine white powder produced by controlled soaking of quicklime, are described, followed by a review of its possible applications in connection with the treatment of water and effluents. Methods of utilization, either directly in powder form or as a suspension in water (milk of lime), are considered together with precautions to be observed during storage and handling of the product and first aid treatment to be given in an emergency. Safety measures such as the wearing of protective clothing and spectacles should be strenuously insisted on. (English translation 80 pounds sterling, valid for 1995). **Belgium**

95-0712

**Hydrated lime - LHOCAI - EH90 (ECLAT).**

*Tribune de l'Eau*, 1994, 47, No 570, 64-65 (in French)

The properties of this form of hydrated lime are reviewed. It is slightly coarser in texture and of a lower grade of purity than the alternative form (EH63) but in other respects exhibits generally similar properties and possible uses in connection with the treatment

of water and effluents. Precautions to be taken in handling the material and first aid measures applicable following accidental exposure to it are outlined. (English translation 80 pounds sterling, valid for 1995). **Belgium**

95-0713

**Milled quicklime - LHOCAI - E090 (type EF).**

*Tribune de l'Eau*, 1994, 47, No 570, 66-67 (in French)

The nature and properties of this form of quicklime, produced by calcining of chalk at 900°C, followed by melting to give a product with 98 per cent passing 0.090 mm, are described. Its application in the treatment of water and effluents, methods of use and precautions necessary in storing and handling the product are reviewed. It must be excluded from contact with air and carbon dioxide if it is to retain its original properties, and contact with aluminium must be avoided. (English translation 80 pounds sterling, valid for 1995). **Belgium**

95-0714

**Ready to use milk of lime - IDRACAL.**

*Tribune de l'Eau*, 1994, 47, No 570, 68-69 (in French)

The nature and properties of this form of aqueous suspension of hydrated lime are reviewed. It has a solids content of 30 per cent of which 96.6 per cent consists of calcium hydroxide and is supplied ready for use as a coagulant or neutralizing agent in a wide range of water and effluent treatment processes. Precautions to be observed when storing or handling the product are outlined. (English translation 70 pounds sterling, valid for 1995). **Belgium**

95-0715

**Electrochemical determination at low levels of residual chlorine dioxide in tap water**

F. QUENET (Université de Bretagne Occidentale, Brest), C.

ELLIOUET and C. MADEC

*Analytica Chimica Acta*, 1994, 295, No 1-2, 85-91

In many water treatment plants residual chlorine dioxide could not be reliably determined at levels below 0.1 mg per litre using conventional methods. Thus, an electrochemical method is described for the simple and selective determination of chlorine dioxide at levels between 2-50 µg per litre. The reaction between 1,2-dihydroxyanthraquinone-3-sulphonic acid (DASA) and chlorine dioxide in phosphate buffer was studied both spectrophotometrically and electrochemically. In aqueous phosphate buffer (pH 6.8) DASA exhibited 2 waves on vitreous carbon: an oxidation wave and a reduction wave. The total disappearance of the oxidation wave (0.42 V) was obtained for a chlorine dioxide/DASA molar ratio of 4, but with the electrochemical method a new oxidation wave appeared at a more positive potential. This was attributed to chlorite formation. EDTA was added to eliminate interferences from the formation of a complex between copper and DASA. The measurements were made after a preconcentration step in which the solution was stirred for 90 seconds at a potential of minus 0.3 V. The proposed method was applied to the determination of chlorine dioxide in tap water and compared with the direct N,N-diethyl-p-phenylenediamine (DPD) spectrophotometric method and the selective indirect Chlorophenol Red (CPR) spectrophotometric method. The detection limit for chlorine dioxide was 2 µg per litre, better than that of the spectrophotometric (DPD) method (20 µg per litre). **France**

95-0716

## Determination of sulphur by tin, aluminium and indium monosulphide molecular absorption spectrometry using sharp line irradiation sources.

P. PARVINEN (Osaka University), and T. H. J. LAJTHA. *Analytica Chimica Acta*, 1994, **295**, No 1/2, 205-210.

Methods for the determination of sulphur by molecular absorption using sharp line irradiation sources (hollow cathode lamps of different elements) were both sensitive and accurate. Sulphur was determined via the molecular absorption of aluminium, indium and tin sulphides. The best result was obtained when sulphur was measured as tin sulphide by the tungsten line (tungsten hollow cathode lamp) at 273.5 nm, or as indium sulphide by the platinum line (platinum hollow cathode lamp) at 243.67 nm. Interference studies on the determination of sulphur in solutions containing 100 mg sulphur per litre and 1 g interferent per litre showed that the strongest interferences were caused by barium and manganese (sulphur found was 49 mg per litre). The detection limit when measuring sulphur as tin sulphide was 1 mg per litre, and as indium sulphide was 2.5 mg per litre. The methods were tested for the determination of sulphur in some organic compounds and in rain water samples. **Finland**

95-0717

## Cathodic stripping potentiometric determination of selenium in biological and environmental materials.

S. B. ADHIJIT (Western Sydney University, Kingswood, N.S.W.), and T. M. YOUNG.

*Analytica Chimica Acta*, 1994, **296**, No 1, 69-76.

Cathodic stripping potentiometry (CSP) with a glassy carbon mercury film electrode (GC-MFE) was used for the trace level determination of selenium in environmental and biological samples. Optimal conditions included hydrochloric acid (3 M) as supporting electrolyte, an electrolysis potential of minus 100 mV versus a saturated calomel reference electrode (SCE), a constant reduction current of minus 20  $\mu$ A, and the decomposition of the samples by dry ashing with magnesium nitrate. The selenium detection limit was 0.8  $\mu$ g per litre with an electrolysis time of 5 minutes, or 0.04  $\mu$ g per litre with 60 minutes deposition (RSD was 6 per cent). The suppression of the selenium peak caused by interferents such as lead, copper, cadmium, zinc, cetyltrimethylammonium bromide (CTMAB), lauryl pyridinium chloride (LPC), lauryl sodium dodecyl benzene (LAS), and Triton X-100, was overcome by the use of standard additions method and a UV irradiation procedure (removal of organics). UV irradiation of the digested environmental and biological materials reduced the required dry ashing period to 1 h and improved the sensitivity and accuracy of the method. The method was applied to the determination of selenium in several standard reference materials: IAEA/Monaco MA-2 (fish tissue), IAEA H8 (horse kidney), and IAEA H9 (mixed human diet). With UV pretreatment of samples, results were in good agreement with certified values. **Australia**

95-0718

## Determination of selenium(IV) and selenium(VI) in natural water samples by neutron activation analysis after chemical pre-collection.

Y. SAKAI (Daigo Institute of Technology, Nagoya), K. TOMURA, and K. OHSHITA.

*Journal of Radioanalytical and Nuclear Chemistry Letters*, 1994, **187**, No 6, 441-450.

Selenium(IV) and selenium(VI) were determined in natural river and sea water samples by preconcentration of selenium on activated carbon prior to neutron activation analysis (NAA). NAA employed

the short-lived selenium-77 isotope. Selenium(IV) was adsorbed as its selenium(IV)/bismuthiol-II complex on activated carbon. Selenium(VI) was reduced to selenium(IV) using concentrated hydrochloric acid (4 M) and hydroxylamine hydrochloride (7.5 g per litre) at a temperature of 99°C. Thus selenium(IV) was measured before and after reduction of selenium(VI). The difference between the 2 readings equated to the selenium(VI) concentration. Selenium(IV) and selenium(VI) were determined at levels below 1  $\mu$ g per litre using this method. Trace amounts of both were found in Japanese river, sea and groundwaters. **Japan**

95-0719

## Flow injection reagent introduction by supported liquid and Nafion membranes: determination of phosphate.

S. T. CHAIK (Massachusetts University, Amherst), and J. F. TYSON.

*Talanta*, 1994, **41**, No 10, 1797-1805.

The introduction of the 3 reagents required for the determination of phosphate by the Heteropoly Blue method was accomplished using membrane reactors. The use of membranes eliminated the need for confluence points in the design of flow injection manifolds. The effect of this was to increase the sensitivity of the manifold by providing a sufficient excess of reagent for the reaction without diluting the sample. Nafion and Accurel (a microporous polypropylene) were the most suitable membranes for this application. Calibration was linear and a detection limit of 12 ppb of phosphate was achieved. There are 47 references. **U.S.A.**

95-0720

## Determination of trace elements in small water samples by total reflection X-ray fluorescence (TXRF) and by neutron activation analysis (NAA).

K. H. J. SER (Technische Hochschule, Darmstadt), M. FLAKOWSKI, and P. HOFFMANN.

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 3, 135-138.

The applicability of total reflection X-ray fluorescence (TXRF) and neutron activation analysis (NAA) techniques for the analysis of very small volumes of aqueous solution (1-10  $\mu$ l) was investigated and the results are compared. Sodium, magnesium, potassium, calcium, manganese, iron, cobalt and copper were selected as representative elements in atmospheric samples (one rain droplet). Sodium and magnesium at levels of 10 ng or less could not be determined by either TXRF or NAA. Potassium was determined by TXRF in amounts above 2.5 ng but could only be determined by NAA at 10 ng or greater. Calcium could be determined by TXRF above 30 pg but not by NAA. Manganese, iron, cobalt and copper were detectable by TXRF at 5, 5, 5 and 2 pg, respectively. Manganese and cobalt could be determined by NAA in amounts of 1 ng provided samples were measured shortly after the end of irradiation. TXRF had clear advantages over instrumental NAA for all the metals tested.

**Germany**

95-0721

**Application of the Taguchi experimental design to the optimization of a photo-oxidation procedure for trace metal analysis in freshwater.**

M. VEGA (Valladolid University), R. PARDO, E. BARRADO, M. A. de la FUENTE, and J. L. del VALLE

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 3, 139-144

The Taguchi experimental design (also called parameter design) was applied to the optimization of a photolytic decomposition procedure for dissolved organic matter (DOM) in river waters to determine traces of zinc, cadmium, lead and copper bound to DOM as inert species by differential pulse anodic stripping voltammetry (DPASV). Four control factors at 3 levels were investigated. These were exposure time to UV irradiation, pH of the sample, hydrogen peroxide concentration and mineral acid added. Design matrices called orthogonal arrays were used to differentiate control factors from uncontrollable factors. Thus the photodigestor performance was optimized. Optimal response (insensitive to variations of DOM concentration) was found when samples acidified at pH 2 with sulphuric acid were irradiated for 30 minutes in the presence of 12.3 mmol hydrogen peroxide per litre. The proposed procedure was more precise, accurate and fast than the wet digestion method and was successfully applied to speciation studies of cadmium, copper, lead and zinc by DPASV in Pisuerga river samples. **Spain**

95-0722

**Ion chromatographic determination of alkali and alkaline earth metals in mineral waters.**

N. GRON (Ljubljana University) and B. GORENC

*Chromatographia*, 1994, 39, No 7/8, 448-452

A cation exchange column, IonPac CS12, was used for the rapid simultaneous, suppressed ion chromatographic determination of alkali metal, alkaline earth metals and ammonium in highly mineralized waters. The IonPac CS12 column offered several advantages over previous cation exchangers, including a shorter run time, higher capacity, better sodium/ammonium selectivity and better ammonium/potassium selectivity. In IonPac CS12 the sulphonic functionality had been replaced by a carboxylic functionality which enabled the use of low ionic strength eluents. The introduction of methane sulphonic acid as an eluent enabled the use of a self-regenerating suppressor which excluded the need for the regenerant tetraethylammonium hydroxide, thus reducing costs. A DIONEX conductimetric detector II (CMD) was used. The relative standard deviations (RSD) of retention times for lithium, sodium, potassium, ammonium, magnesium, calcium and strontium were below 0.7 per cent and the RSD of peak height/area measurements were below 5 per cent. Six natural mineral waters were selected for method evaluation. Sample pretreatment included degassing, dilution and neutralization of hydrogen carbonate with hydrochloric acid. All relationships between peak areas/height and concentrations were linear and there was no evidence of matrix effects on the slope of regression lines. **Slovenia**

95-0723

**Heavy metals in sludge from the sewage treatment plant of Rio de Janeiro.**

Y. LANGENBACH (Universidade Federal do Rio de Janeiro), W. PFEIFER, I. R. FREIRE, M. SARPA and S. PAIM

*Environmental Technology*, 1994, 15, No 10, 997-1000

Specimens from the Penha urban sewage treatment plant were collected and analysed for cadmium, zinc, copper, lead and nickel using atomic absorption spectrometry after sludge digestion with 4N nitric

acid. These heavy metal concentrations were within European levels with the exception of lead and nickel which exceeded median U.S.A. levels of 500 mg and 50 mg per kg respectively, although they were within the range of European Union and U.S.A. recommended standards. A feature of marine soils in Rio de Janeiro is their high natural salt content, so that salination monitoring may be required to avoid sludge salination in cases where very high sludge concentrations are added to the soils. **Brazil**

95-0724

**Synthesis of a chelating polymer matrix by immobilizing Alizarin Red-S on Amberlite XAD-2 and its application to the preconcentration of lead(II), cadmium(II), zinc(II) and nickel(II).**

R. SAXENA (Indian Institute of Technology, New Delhi), A. K. SINGH and S. S. SAMBI

*Analytica Chimica Acta*, 1994, 295, No 1/2, 199-204

The synthesis of Alizarin Red-S loaded Amberlite XAD-2 via covalent linkage of the Alizarin Red-S with the benzene ring of the polymer Amberlite XAD-2 through a diazo group is reported. The sorption characteristics of the resultant chelating polymer matrix and its application to the preconcentration of zinc(II), cadmium(II), nickel(II) and lead(II) prior to their determination by flame atomic absorption spectrometry (FAAS) are also described. The newly synthesized resin was characterized by elemental analyses, thermogravimetric analysis and infra-red and reflectance spectroscopy. For the quantitative sorption and recovery of zinc, cadmium, nickel and lead, the optimal pH and eluents were pH 5.6 and 4 M hydrochloric acid or 1 M nitric acid (zinc), pH 5.6 and 4 M nitric acid (cadmium), pH 3.4 and 4 M hydrochloric acid or 2 M nitric acid (nickel) and pH 6 and 3.4 M nitric acid (lead). The resin sorption capacities were 511 (zinc), 124 (cadmium), 139 (nickel) and 306 (lead) µg per g of resin. Tolerance limits of sodium fluoride, sodium chloride, sodium sulphate, sodium phosphate and sodium nitrate on the sorption of these metal ions are reported. Sodium nitrate interfered in the sorption of all the metal ions except lead(II). The preconcentration factor was 40 for all 4 metals and the lower limit of preconcentration was 0.01 mg per dm<sup>3</sup>. Precision (RSD) were in the range 3.7-8.2 per cent. This chelating polymer resin was used for the determination of zinc, cadmium, nickel and lead in well water samples. **India**

95-0725

**Kinetic studies of metal speciation using Chelex cation exchange resin: application to cadmium, copper, and lead speciation in river water and snow.**

C. I. CHAKRABARTI (Carleton University, Ottawa, Ont.), Y. LIU, D. C. GREGOIRE, M. H. BACK and W. H. SCHROEDER

*Environmental Science & Technology*, 1994, 28, No 11, 1957-1967

The kinetics of cadmium(II), copper(II) and lead(II) speciation in river surface water and snow samples were measured using the Chelex batch technique and model solutions containing the metal ions and the complexants EDTA, nitrilotriacetic acid (NTA) and fulvic acid. The metal ions were measured by inductively coupled plasma mass spectrometry. Rates of metal uptake were analysed by the iterative deconvolution method. In the presence of excess EDTA or NTA the metals formed slowly dissociating complexes. In the presence of fulvic acid the metals formed strongly bound complexes with a range of slow dissociation rates. The fulvic acid/metal ion ratio and the extent of occupation of binding sites in fulvic acid on the lability of metal-fulvic acid complexes was important. There are 55 references. **Canada**

95-0726

**Clean technique measurement of Pb, Ag, and Cd in freshwater: a redefinition of metal pollution.**

G. BENOFF (Yale School of Forestry and Environmental Studies, New Haven, Conn.)

*Environmental Science & Technology* 1994, 28, No 11, 1987-1991

Water samples from the Quinnipiac river, Conn., U.S.A., collected under high and low flow conditions in 1993, were analysed for lead, silver and cadmium using clean techniques (preconcentration by evaporation with nitric acid and graphite furnace atomic absorption spectroscopy). Nearly all metal measurements were in the ppt range compared to ppb levels in previous U.S. Geological Survey data for the same site. All 3 metals occurred at much higher levels in middle and lower reaches of the Quinnipiac river than in the tributaries and headwaters. At all sampling locations, metal levels were below the detection limits of routine monitoring measurements by governmental agencies. It might be necessary to redefine the level at which a river is considered polluted with heavy metals. There are 30 references. U.S.A.

95-0727

**Field screening of chromium, cadmium, zinc, copper, and lead in sediments by stripping analysis**

K. B. OLSEN (Pacific Northwest Laboratory, Richland, Wash.), J. WANG, R. SETIADJI and J. LU

*Environmental Science & Technology* 1994, 28, No 12, 2074-2079

Sediment samples were dried in a microwave oven, acid digested with nitric acid and analysed by stripping voltammetric methods which were easier to use in field laboratories than more traditional techniques. Total chromium and chromium species were examined by adsorptive stripping voltammetry, cadmium, zinc, copper and lead were analysed by anodic stripping voltammetry and potentiometric stripping analysis. These investigations demonstrated the value of stripping techniques for on-site identification of contaminated layers in soils and sediments. The values agreed with those obtained by U.S. EPA procedures. They offered sensitivity, portability, low power requirements and low cost. Detection limits were around 1 ppb. Standard addition techniques improved accuracy and identified interferences. U.S.A.

95-0728

**Fluorimetric flow-through sensor for aluminium speciation**

P. CANIZARES (Cordoba University) and M. D. LUQUE de CASTRO

*Analytica Chimica Acta* 1994, 295, No 1/2, 59-65

A flow-through sensor for aluminium speciation is described in which the sensor consisted of an aluminium salicylaldehyde phenylhydrazide (SAPH) fluorescent complex retained on a support resin (several were tested) packed in the flow cell located in a conventional spectrofluorimeter. The method exploited the separation model described by Driscoll to discriminate between the different forms of aluminium. Three aluminium species (acid reactive aluminium, total monomeric aluminium and non-labile monomeric aluminium) were determined and 2 other forms (acid-soluble and labile monomeric) were calculated as the difference by injecting 3 sample aliquots into the continuous system and making use of an in-line ion-exchange microcolumn. Thus a series of chemical steps were carried out before the sample reached the sensing device. These steps were pH adjustment, ion-exchange separation and derivatization to give the analytes a suitable form for detection. The sensor was

automatically regenerated by switching an injection valve. The overall system was applied to aluminium speciation in different types of water. Spain.

95-0729

**Determination of chromium in biological reference materials by instrumental NAA using Compton suppression.**

S. LANDSBERGER (Illinois University, Urbana) and S. PESHEV

*Journal of Radioanalytical and Nuclear Chemistry* 1994, 181, No 1, 61-70

Instrumental neutron activation analysis (INAA) combined with Compton suppression methods were used to determine chromium concentrations in 10 biological and botanical certified reference materials (NIST), 2 marine samples (NRC of Canada, DOLT-1 and DORM-1) and one milk powder from the IAEA (A-11). Special attention was given to the interferences and ways of minimizing them. The INAA method was not applicable for some matrices with very low chromium concentrations because of the detection limit imposed by the spectral interferences, principally by phosphorus-32 Bremsstrahlung radiation. A detection limit of 19 ng/g for SRM 1567a (wheat flour) was achieved. The advantages of the INAA procedure included its simplicity and the avoidance of tedious chemical separations. Using Compton suppression methods the reduction in detection limits achieved was between 20-40 per cent, however little improvement in statistical precision was observed. Most significantly, the Compton system reduced neodymium interference. Results for chromium were in good agreement with certified or compilation values. U.S.A.

95-0730

**Stability, stoichiometry, and structure of Fe(II) and Fe(III) complexes with di-2-pyridyl ketone benzoylhydrazone: environmental applications.**

M. E. V. S. AREZ/HA (California Institute of Technology, Pasadena), S. O. PEHKONEN and M. R. HOFFMANN

*Environmental Science & Technology* 1994, 28, No 12, 2080-2086

The properties of iron complexes of di-2-pyridyl ketone benzoylhydrazone (DPKBH) were studied at 25°C and pH 5-3 with water-ethanol solutions. DPKBH was synthesized from di-2-pyridyl ketone and benzoylhydrazone. Spectrophotometric measurements were made at 410 and 660 nm, respectively. Potentiometric and conductance measurements were also obtained. Overall formation constants of complexes of iron(II) and iron(III) with 1 and 2 DPKBH molecules were obtained by the spectrophotometric method of corresponding solutions. DPKBH coordinated preferentially as an anion in enol form acting as a tridentate ligand. It was a useful ligand for the simultaneous spectroscopic determination of iron(II) and iron(III). There are 50 references. U.S.A.

95-0731

**Response of copper(II) ion-selective electrodes in seawater.**

R. De MARCO (Tasmania University, Launceston)

*Analytical Chemistry* 1994, 66, No 19, 3202-3207

A comparison of the responses of 3 types of copper(II) ion-selective electrode (copper sulphide, copper selenide and copper/silver sulphide) was undertaken in artificial and real seawater samples. X-ray photoelectron spectroscopy and X-ray diffraction demonstrated that the unacceptably high detection limit of the copper sulphide electrode (0.1 mM copper(II) ions) was due to membrane oxidation to copper sulphate and other copper species. Corrosion of the copper

selenide electrode led to seawater contamination with high levels of copper(II). The copper/silver sulphide electrode released much lower amounts of copper (II). Copper selenide and copper/silver sulphide electrodes displayed Nernstian responses in the range 1000000-10 nM of free copper(II) with copper(II) ethylene diamine buffers also containing 0.6 M sodium chloride. The copper/silver sulphide ion-selective electrode (ISE) was the preferred electrode. *In-situ* environmental monitoring of copper(II) during a sea voyage was possible by incorporation of this ISE in a flow injection analyser. Copper(II) contamination of the seawater was minimized by carrying out analyses in the absence of light and dissolved oxygen. **Australia**

95-0732

**Speciation of arsenic in natural waters by solvent extraction and hydride generation atomic absorption spectrometry.**

H. HASEGAWA (Kochi University), Y. SOHRIN, M. MATSUI, M. HOJO and M. KAWASHIMA

*Analytical Chemistry*, 1994, **66**, No 19, 3247-3252

Arsenious acid (arsenic), monomethylarsonous acid (MMAA) and dimethylarsinous acid (DMAA) were separated from pentavalent species by solvent extraction using diethylammonium diethyldithiocarbamate (DDDC), and determined by hydride generation atomic absorption spectrometry (HG-AAS) after cold trapping and chromatographic separation. The total of the concentrations of arsenic(III) and arsenic(V) species were determined in another aliquot of the same sample enabling the arsenic(V) pentavalent species to be obtained as the difference. This method eliminated inaccuracies associated with changing arsenic species during sample storage. More accurate values for arsenic(III) were obtained than with conventional HG-AAS. Detection limits for the trivalent species were in the range 13-17 pM. Some results of arsenic speciation in Japanese waters are presented showing the first distribution of MMAA and DMAA in aquatic systems. There are 35 references. **Japan**

95-0733

**Extraction spectrophotometric determination of selenium(IV) with J acid in environmental samples.**

R. MANISH (Pt Ravishankar Shukla University Raipur), K. N. RAMACHANDRAN and V. K. GUPTA

*Talanta*, 1994, **41**, No 10, 1623-1626

A simple procedure for the extraction and spectrophotometric determination of trace levels of selenium(IV) was developed. Selenium(IV) was reacted with 6-amino-1-naphthol-3-sulphonic acid (J acid) to form a butanol-extractable complex. The reaction involved a colour change and was free from interference by more than 25 ions which were investigated. The analytical parameters were optimized and the procedure was applied to the determination of selenium(IV) in polluted water, cereals, soil, human hair and steelworks dust. The reproducibility of the method was confirmed. The recovery of a spiked sample was in the range 96-98.6 per cent. The reagent, J acid, was easily available, non-toxic and stable. **India**

95-0734

**Determination of dissolved selenium(VI) in freshwater.**

U. ORNEMARK (Uppsala University) and A. OLIN

*Talanta*, 1994, **41**, No 10, 1675-1681

The determination of dissolved selenium(VI) in freshwaters with high concentrations of dissolved organic materials was investigated. Possible sources of error in selenium determination are considered. An ion exchange procedure which allowed inorganic selenium(IV) and selenium(VI) to be pre-concentrated and separated was devel-

oped. Following an initial cleaning step using XAD-8, selenate was collected on a strong anion exchanger and subsequently eluted with hydrochloric acid. Following conversion to the tetravalent state, selenium was determined using atomic absorption spectrometry after hydride generation and pre-concentration in a cold trap system. **Sweden**

95-0735

**On-line preconcentration and determination of trace platinum by flow-injection atomic absorption spectrometry.**

A. CANTARERO (Universidad Complutense Madrid), M. M. GOMEZ, C. CAMARA and M. A. PALACIOS

*Analytica Chimica Acta*, 1994, **296**, No 2, 205-211

Activated alumina microcolumns were used for the on-line trace enrichment of platinum(IV) in its chlorocomplex prior to its determination on-line by flame atomic absorption spectrometry (FAAS). Nitric acid (0.01 M) was used as the carrier solution. On-line preconcentrations were followed by graphite furnace atomic absorption spectrometry (GFAAS). Preconcentration factors for FAAS (25 µl elution volume) and for GFAAS (500 µl elution volume) were 600 and 30, respectively, both with a 15 ml sampling volume. Detection limits in these conditions were 0.02 mg per litre (relative standard deviation 9 per cent) for FAAS and 0.33 µg per litre (relative standard deviation 7 per cent) for GFAAS. The proposed on-line method was suitable for the determination of platinum in natural waters at sub-ng per litre (ppb) levels. Sub-µg per litre (ppb) levels were determined using off-line platinum preconcentration and final determination by GFAAS. **Spain**

95-0736

**Square-wave voltammetric determination of lead(II) with a Nafion/2,2-bipyridyl mercury film electrode.**

J. M. ZHENG (National Chung Hsing University, Taichung), S. Y. HUANG

*Analytica Chimica Acta*, 1994, **296**, No 1, 77-86

The complexing agent 2,2-bipyridyl (Bpy) was used to fabricate a chemically modified electrode (CME). Thus, a system consisting of a Nafion (ion exchange polymer) coated mercury film electrode containing appropriate amounts of Bpy was used for lead(II) analysis. Square-wave stripping voltammetry (SWSV) was used in combination with the CME for the determination of the reversible lead(II)-Bpy complex. This CME exhibited better mechanical stability than an unmodified mercury film and improved resistance to interference from surfactants and metals known to commonly interfere in anodic stripping measurements. A linear calibration curve was obtained from 1-100 µg per litre, using a 5 minute preconcentration period in the presence of oxygen. The detection limit was 0.1 µg per litre but this limit could be lowered with longer preconcentration periods. Acid was used to regenerate the CME surface. The SWSV response was reproduced with a 5 per cent relative standard deviation for 10 successive preconcentration/determination/renewal cycles. The CME was recommended for use in continuous monitoring in environmental or clinical applications. **Taiwan**

95-0737

## Determination of trace level mercury in biological and environmental samples by neutron activation analysis

P. SHETTY (Eastern Michigan University, Ypsilanti), A. A. MOOSAVI MOVAHEDI, and K. RENGAN  
*Journal of Radioanalytical and Nuclear Chemistry*, 1994, **182**, No 2, 205-211

The optimal conditions for the sorption of mercury ions by Chelex 100 chelating resin were determined and a radiochemical procedure for the determination of mercury in biological and environmental samples by neutron activation analysis was developed. Mercuric chloride, mercuric nitrate and mercuric sulphate tracers were used to elute the columns containing Chelex 100. The eluate fractions were analysed by gamma ray spectroscopy. Sorptivity decreased with increasing sulphate ion concentration and nitrate concentrations. The mercury(II) chloride complex was strongly sorbed at all hydrochloric acid concentrations studied (0.025-6 M). Different resin particle sizes did not change mercuric chloride sorption. The method was validated with orchard leaves and tuna fish standards from the National Institute of Standards and Technology, U.S.A.

95-0738

## Combined filtration-solid-phase extraction method for recovering organic substances from natural waters in preparation for mutagenicity testing.

J. L. DURANT (Massachusetts Institute of Technology, Cambridge), P. A. MONCHAMP, A. L. LAFFEUR, and H. L. HEMOND

*Environmental Science & Technology*, 1994, **28**, No 11, 1819-1828

A filtration-solid-phase extraction method for recovering particulate organic matter and dissolved organic matter from large volumes of natural water (greater than 100 litre samples) in preparation for mutagenicity determination and chemical characterization is described. The system consisted of 0.45 µm poly(vinylidene difluoride) membrane filters mounted in high-pressure stainless steel filter holders connected in series to HPLC columns packed with equal amounts of octadecyl and cyanopropyl bonded phase sorbents. The filtered and sorbed organic materials were eluted with dichloromethane and methanol. Extracts of cleaned filters and bonded phase sorbents were free of interferences that were toxic or mutagenic to human B cells and *Salmonella typhimurium*. A 100 litre high purity water sample was pumped through the system and was free of detectable human B cell or *S. typhimurium* mutagens. Two water samples from the Aberjona river, Mass., U.S.A. were passed through the system and the resulting POM and DOM fractions were tested for mutagenicity in human B cells and *S. typhimurium*. The POM extract from one sample was mutagenic to human B cells. Benzo(a)pyrene was found in this extract. There are 68 references. U.S.A.

95-0739

## Henry's Law constants and infinite dilution activity coefficients for volatile organic compounds in water by a validated batch air stripping method.

F. NILI-SIN (National Institute of Occupational Health, Copenhagen), L. OLSEN, and A. FREDERSEN  
*Environmental Science & Technology*, 1994, **28**, No 12, 2133-2138

Henry's Law constants and activity coefficients of volatile organic compounds were calculated from data obtained by diffusing water saturated air into an aqueous solution of the compounds. The air flow

stirred the water, ensuring homogeneity of the liquid phase and equilibrium between vapour and dissolved organic compound. Vapour composition was measured by a photoionization detector. Infinite dilution activity coefficients could be calculated from the ratio of Henry's Law constant to the pure component vapour pressure. Equilibrium could not be achieved for compounds with Henry's Law constants exceeding 200,000 kPa so accurate values were impossible unless the apparatus was modified with a taller column, and a higher recirculation rate. It was hoped to use the accurate infinite dilution activity coefficient as a basis for extending UNIFAC group-interaction parameter tables. Denmark.

95-0740

## Monitoring of petroleum hydrocarbon pollution in surface waters by a direct comparison of fluorescence spectroscopy and remote sensing techniques.

L. DE DOMENICO (Thalassografic Institute, Raineri), E. CRISAFI, G. MAGAZZU, A. PUGLISI, and A. LA ROSA  
*Marine Pollution Bulletin*, 1994, **28**, No 10, 587-591

An aerial survey of oil pollution in a natural harbour in Sicily was carried out using a Bispectral Scanner System, which operated in ultraviolet and infrared bands. At the same time, surface water samples were taken and the aromatic hydrocarbon content was determined by fluorescence spectroscopy in terms of both chrysene and Kuwait crude oil. The results from the analysis were used to produce isopleths joining points of equal hydrocarbon content. These were in good agreement with the hard copy images from the remote sensing and could be used to calibrate the images. The data from the 2 methods were combined to produce a colour coded map of the oil pollution. Italy.

95-0741

## Strohlein analyser simplifies organic halogen determination

S. BAUMANN (Strohlein, Kiarst)  
*Water & Wastewater International*, 1994, **9**, No 5, 41-42

Development of a new analyser to measure organic halogen (OX) is reported. High temperature oxidation of OX by oxygen at approximately 1000°C formed a single product, HX. Quantitation was based on microcoulometry allowing determination of sub microgram quantities with no calibration. Liquid and solid matrices were treated similarly. Application of the system to the determination of absorbable organic halogens and extractable organic halogens is reported. Germany.

95-0742

## Application of AMD to the determination of crop-protection agents in drinking water. Part III: solid phase extraction and affecting factors

G. PFAAB (Universitat des Saarlandes, Saarbrücken) and H. JORK  
*Acta Hydrochimica et Hydrobiologica*, 1994, **22**, No 5, 216-223 (in English)

The application of solid phase extraction procedures in connection with the determination of pesticide trace residues was investigated and those factors which influence the rate of recovery of the target compounds during clean up using RP 18 sorbent materials were examined. Differences in the sorption behaviour of the RP 18 materials from different suppliers and production batches were evaluated while the effects of the liquid/solid ratio and the amount of sorbent were also examined. When extracting phenylurea herbicides from drinking water, a ratio of 1 g of sorbent to 1 litre of water should be adhered to. With the fungicides procymidon, vinclozolin and

production, the recovery decreased as the flow rate through the resin increased above 3-6 ml per minute, while for the phenylurea herbicides optimal recoveries were recorded with flow rates of 10-14 ml per minute, coupled with a coefficient of variation of less than 5 per cent. Batch-to-batch variation for products from a single supplier and variations between different suppliers could be as high as approximately 40 per cent. The purity of the solvent used could also have important consequences for the accuracy of the result and concentration by evaporating the extract to a small volume could give rise to significant losses, especially for those compounds with higher vapour pressures. For linuron the concentration to dryness of 3 ml of a methanol solution resulted in a loss of 14 per cent of the starting material. Such errors were often attributed to sample enrichment whereas they are probably due to volatilization. Germany

95-0743

#### Stability of selected pesticides on solid-phase extraction disks

W. G. JOHNSON (Arkansas University, Fayetteville), T. I. LAVY and S. A. SENSEMAN

*Journal of Environmental Quality*, 1994, 23, No 5, 1027-1031

The relative storage stabilities of 2,4-D, trichlorpyr, carbofuran, molinate, and thiobencarb on C18 solid phase extraction disks were compared to their stability in water at 40°C. Water was fortified with either mixtures of the 5 pesticides at 20 µg of each pesticide per litre or with methanol. Storage treatments included storage in water at 40°C or with analytes extracted onto the SPE disks and stored at 40°C, minus 20°C, or 40°C for 1 d followed by minus 20°C for the remaining storage period. Residues were analysed by GC after 0, 180 d storage. The water solubilities of all chemicals were greater than 300 mg per litre, with the exception of thiobencarb (28 mg per litre). All the studied pesticides were more stable when stored on disks than in water. Carbofuran was the least stable. The 2 treatments that included freezing at minus 20°C resulted in the highest recovery. U.S.A.

95-0744

#### Determination of polycyclic aromatic hydrocarbons in water, sediments, sludge and soil using high performance liquid chromatography.

R. REUPERT (Landesumweltamt, Düsseldorf) and G. BRAUSEN

*Acta Hydrochimica et Hydrobiologica*, 1994, 22, No 5, 202-215 (in German, English summary)

The position regarding the development of reproducible methods for the determination of individual PAH compounds relevant to the monitoring of water quality is reviewed, with detailed accounts of the methods and equipment employed for extraction of the largest compounds from the original matrix and their chromatographic separation using PAH sensitive columns and quantitative estimation using programmed fluorescence detection equipment. An improved method of PAH extraction from soils is described which employed ultrasonic excitation of a suspension using either tetrahydrofuran or acetonitrile as solvents, in place of the customary Soxhlet extraction technique. Results obtained by both methods for a variety of different soil samples are presented indicating that the recoveries obtained by the ultrasonic method were at least as good as those given by the traditional method. The detection system enabled 15 separate PAH compounds and isomers to be determined simultaneously including the group of 6 specified in the German drinking water quality legislation (English translation 345 pounds sterling, valid for 1995). Germany

95-0745

#### Determination of organophosphorus and carbamate pesticides with an acetylcholinesterase amperometric biosensor using 4-aminophenyl acetate as substrate.

C. la ROSA (Universidad Autonoma de Madrid), I. PARIÑI, I. HERNÁNDEZ, and E. LORENZO

*Analítica Química Acta*, 1994, 295, No 3, 273-282

4-Aminophenyl acetate (PAPA) representing a good substrate for the determination of esterase activities via oxidation of 4-aminophenol (PAP), the product of the enzymatic reaction, was used as a substrate in an amperometric biosensor based on immobilized acetylcholinesterase (AChE). The response time, pH response, linear range, kinetic parameters and other features of this biosensor were described previously. Here, the possibility of applying this biosensor system to inhibition studies of esterase activities by xenobiotic agents (organophosphorus and carbamate pesticides) was investigated, and this inhibition applied to the determination of these pesticide agents. The glassy carbon enzyme membrane covered electrode, poised at plus 250 mV (vs. sodium chloride saturated calomel electrode), oxidized PAP, formed in the hydrolysis of PAPA by AChE, in the glutaraldehyde cross-linked layer. The decrease in AChE activity was correlated to the concentration of pesticide in solution. Detection limits of 4.0 and 13.0 nmol per litre for paraoxon and carbaryl, respectively, were achieved with a 3 minute preincubation time. There are 13 references. Spain

95-0746

#### Extraction and analysis of various benzothiazoles from industrial wastewater

O. EILHN (Berlin Technical University), I. REHMISMA and M. JEKEL

*Analítica Química Acta*, 1994, 295, No 3, 297-305

A method was developed for the extraction and analysis of benzothiazole (BT), 2-mercaptobenzothiazole (MBT), 2-(methylthio)benzothiazole (MTB), and 2-(thiovanomethylthio)benzothiazole (TCMTB) from industrial wastewaters (rubber industry and metal finishing liquors). The method involved liquid-liquid extraction with ethyl acetate and toluene at pH 8.5, separation by liquid chromatography (LC) using a reversed phase RP-18 column and an acetonitrile-water gradient with UV detection at variable wavelengths. LC analysis was compared with the potential of gas chromatography and its advantages are discussed. Solid phase extraction was unsuitable for some of the benzothiazoles. Determination limits down to 5 µg per litre were achieved, without the need for clean up steps, and with recovery rates greater than 90 per cent. Dissolved organic carbon (DOC) contents up to 900 mg per litre did not interfere with either extraction or chromatographic separation. Germany

95-0747

#### Determination of hydroxy-s-triazines in water using HPLC or GC-MS

H. TARBILR (Institut für Sedimentforschung der Universität Heidelberg), K. NICK and H. F. SCHOLLER

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 3, 145-149

Two methods are described for the determination of triazine herbicide degradation products in water. For both methods RP-C18 solid phase extraction cartridges were used for the simultaneous enrichment of hydroxy atrazine (OHA), hydroxy simazine (OHS), hydroxy propazine (OHP), hydroxy terbutylazine (OHT) and hydroxy desethylatrazine (OHDEA). Separation and detection of these



## MONITORING AND ANALYSIS

compounds was carried out using either high performance liquid chromatography (HPLC) or gas chromatography mass spectrometry (GC/MS). The latter technique required the hydroxy metabolites to be derivatized by methylation with diazomethane. The HPLC set-up was suitable for the detection of all the hydroxy triazines including hydroxy desisopropylatrazine (OHDEA) and cyanuric acid (CA). Average recoveries at concentration levels between 50 ng per litre to 1 µg per litre ranged from 35-43 per cent for GC/MS and from 53-75 per cent for HPLC with the exception of OHDEA (21 per cent). OHDEA, OHDEA and CA could not be enriched on RP-C18. Further investigation focused on the optimization of the chosen methylation method with diazomethane by using different solvents. The HPLC method was quicker and gave better recoveries but the GC/MS method had the advantage of accurate identification of the compounds. There are 31 references. **Germany**

95-0748

### Determination of chlorinated 5-methyl-5-hydroxyfuranones in drinking water, in chlorinated humic water, and in pulp bleaching liquor

R. FRANZIN (Abo Akademi University, Turku) and I. KRONBERG

*Environmental Science & Technology* 1994, 28, No 12, 2222-2227

Three samples of drinking water, a chlorinated natural humic water and extracts from the chlorination stage bleaching liquors from a pulp mill were examined for hydroxyfuranones with mono-, di- and trichloromethyl groups at the C-5 position. Their stabilities in water at pH 2 and 8 were examined. Analysis was by gas chromatography mass spectrometry after methylation. Ames mutagenicity tests were also carried out. The compounds were common in the bleach liquors, some as high as 0.5 mg per litre. The 5-dichloromethyl compounds and one 5-monochloromethyl compound were detected at up to 45 ng per litre. All were mutagenic, but their contribution to total mutagenicity of the drinking water was below 1 per cent. The compounds with higher degrees of chlorine substitution were most stable and all increased in stability at low pH. **Finland**

95-0749

### C<sub>18</sub> solid-phase extraction of the pyrethroid insecticide fenvalerate and the chloroacetanilide herbicide metazachlor from pond water

P. WOJN (Lund University)

*Science of the Total Environment* 1994, 156, No 1, 67-75

A method for the simultaneous determination of the pyrethroid insecticide fenvalerate and the chloroacetanilide herbicide metazachlor in pond water was developed using solid-phase extraction on a C<sub>18</sub> column eluted with ethyl acetate and GC with electrochemical detection. Gas chromatography was conducted with a DB-5 column (30 m by 0.3 mm internal diameter) operated with temperature programming from 110°C (held for 3 minutes) to 270°C (held for 10 minutes) at a 20°C per minute increase and hydrogen as carrier gas (2.5 ml per minute). The method was used to determine the concentrations of fenvalerate and metazachlor in spiked tap water, pond water and river water. The recovery rates were 84 per cent for fenvalerate and 101 per cent for metazachlor. **Sweden**

95-0750

### Gas chromatographic separation of the enantiomers of bromocyclen in fish samples

B. PFÄFFENBERGER (Hamburg University, Germany), H. HÜHNERFLUSS, B. GEHRCKE, I. HARDT, W. A. KÖNIG and G. KIMKUS

*Chemosphere* 1994, 29, No 7, 1385-1391

Fish from fish farms in Denmark and the Stör river in Germany were analysed for the insecticide bromocyclen. Rainbow trout (*Oncorhynchus mykiss*) from the fish farms and orfe (*Leuciscus idus*) bream (*Ambranis brama orientalis*) and pike (*Esox lucius*) were studied. Fish samples were extracted with cold water-acetone-petrol ether followed by clean up by gel permeation chromatography followed by silica gel adsorption chromatography and analysis by capillary gas chromatography. High concentrations of bromocyclen were found (0.093-1.233 mg per kg fat) regardless of whether the fish were from fish farm or river. The enantiomers of bromocyclen in fish samples were separated by high resolution gas chromatography using a chiral stationary phase. **Europe**

95-0751

### Determination of the pesticide carbaryl by chemical deoxygenation micellar-stabilized room temperature phosphorescence

W. YANSHENG (Shanxi University, Taiyuan), J. WEIJUN, Z. ROHUA, L. CHANGSONG and Z. SUSHE

*Talanta* 1994, 41, No 10, 1617-1621

A method for the determination of the aminobenzoate pesticide carbaryl in water using micellar-stabilized phosphorescence at room temperature with sodium sulphite as oxygen scavenger was developed. Optimal conditions for carbaryl determination are considered in detail. The recent discovery that sulphite ion can be used in micellar-stabilized phosphorescence as an effective oxygen scavenger represented a major advance in the use of the technique. The chemical deoxygenation technique was improved and a new mechanism for this process proposed. A standard spectrofluorometer was used. A recovery of 90-100 per cent was achieved with 0.05-0.1 ppm carbaryl. **China**

95-0752

### Adsorptive stripping voltammetry following solid-phase extraction for the trace analysis of fenchlorazol-ethyl in tap water

A. MIYER (Universität Trier) and G. HEINZ

*Revue de l'Analyse Chimique* 1994, 350, No 3, 150-154

Fenchlorazol-ethyl, also known as the herbicide phytopharmakon, was isolated from tap water using disposable Carbopack solid-phase extraction columns prior to determination by adsorptive stripping voltammetry (ASV). The use of Carbopack instead of C<sub>18</sub> columns resulted in a higher sensitivity and an increased linear concentration range. The stripping response was evaluated with respect to pH, accumulation time, potential and mercury drop size. In consideration of the recovery rate the fenchlorazol-ethyl detectable level after 10 minutes accumulation at minus 0.1 V was found to be 0.2 µg per litre in 1 litre of water. This technique was useful for phytopharmakon determinations in mixtures containing the electrochemically inactive herbicide fenoxaprop-ethyl. **Germany**

95-0753

**Molecular weight, polydispersity, and spectroscopic properties of aquatic humic substances.**

Y. P. CHIN (Ohio State University, Columbus) G. AIKEN and E. O'DOUGHLIN

*Environmental Science & Technology*, 1994, 28, No 11, 1853-1858

The number- and weight-averaged molecular weights of aquatic fulvic acids from the U.S.A. and Antarctica, a commercial humic acid and unfractionated organic matter from the Suwannee river (Ga.) were measured by high-pressure size exclusion chromatography (HPSEC). The spectroscopic properties of the humic samples were studied. The molecular weights obtained using HPSEC were in general agreement with those obtained by other methods. Aquatic humic substances were smaller and less polydisperse than previously believed. There was a strong correlation between molar absorptivity, total aromaticity, and the weight average molecular weights of all the humic substances. This suggested that bulk spectroscopic properties could be used to estimate the size of humic substances and their aromatic contents. There are 45 references. U.S.A.

95-0754

**Speciation of particulate uranium in seawater: mass balance analysis of sequential leaching experiments.**

K. HIROSE (Meteorological Research Institute, Ibaraki)

*Journal of Radioanalytical and Nuclear Chemistry*, 1994, 181, No 1, 11-24

The stepwise dissolution of uranium in oceanic particulate matter samples was carried out using leaching solutions of different acid strengths. Mass action analysis on the leaching processes revealed that the major species of particulate uranium in seawater was an organic complex of uranium(VI) which was completely dissociated in the leaching solution of pH 1.0. Inert uranium, a minor species, which was not dissolved in the pH 1 leachate, was thought to consist of an organic complex of uranium(IV). An additional experiment was carried out to determine the effect of ionic strength change and complexation by chloride ion. The determination of uranium in each fraction was carried out by alpha spectrometry. The results indicated that an organic binding site in suspended matter reacted as a polyfunctional ligand which had more than 2 stepwise protonation constants within the pH range 2.0 to 8.2. The conditional stability constant ( $\log K_c$ ) of the organic uranium complex in suspended matter, under the conditions of seawater, was between 12 and 16. It was suggested that the organic binding site in suspended matter was able to form stable chelates with metallic elements. Japan

95-0755

**Measurement of neptunium-237 in the marine environment of coastal nuclear sites in India.**

S. K. JHA (BARC, Bombay) and I. S. BHATT

*Journal of Radioanalytical and Nuclear Chemistry*, 1994, 182, No 1, 5-10

Neutron activation analysis was used to monitor levels of neptunium-237 in the marine environment in the vicinity of nuclear fuel reprocessing sites at Trombay and Tarapur. These sites discharged low level liquid radioactive wastes to the marine environment. Neptunium-237 was pre-concentrated from sea water and sediment bulk samples before subjection to neutron activation. One sample from an area unlikely to be affected by the waste discharges was taken as indicating the background concentration in Indian coastal waters. The levels of activity in Trombay and Tarapur sea water and sediments were typical of an area receiving low level waste discharges

and substantially lower than those in Irish sea waters receiving discharges from Sellafield. India

95-0756

**The use of radium isotopic ratio in groundwater as a tool for pollution source identification.**

E. GARCIA AGUILO (Cetesh, Sao Paulo) S. GONCALVES, J. T. FRANCISCO and C. N. SHINOMIYA

*Journal of Radioanalytical and Nuclear Chemistry*, 1994, 182, No 1, 11-19

The possibility that leakage from a radioactive residue storage facility at Botuxim, Brazil, could contaminate the water supply of Itu City, 12 km north of the facility, was investigated. The facility stored 3500 tonnes of a radioactive by-product from the processing of monazite sand. Radium isotopes were measured in groundwater near the site. The concentrations found were slightly higher than those in unaffected drinking water, but measured isotopic ratios were not compatible with calculated values for the residue at various elapsed times. Other possible sources of contamination are considered. The most likely source was mesothorium cake, though there was no record of this material having been stored at the site. Brazil

95-0757

**Tritium content as indicator of environmental character on Taiwan island.**

J. M. CHEN (Chung Yuen Christian University, Chung Li) S. I. CHIOU and C. W. HUANG

*Journal of Radioanalytical and Nuclear Chemistry*, 1994, 181, No 2, 345-352

Tritium concentrations were determined in well water, coastal seawater and reservoir water samples collected from various locations on and around Taiwan island, using a liquid scintillation analyser with a low level standard quench curve (LLSA). Samples were concentrated by electrolysis and tritium levels measured under the optimal conditions of LLSA. The tritium levels were used as an indicator for geographic character and nuclear test monitoring. A characteristic ratio between well water and coastal water was found to be 4.0 in the western side and 5.8 on the eastern side of Taiwan. The tritium content of reservoir water was related to the logarithm of effective volume capacity. Taiwan

95-0758

**Determination of inorganic species in seepage water of uranium-mining rockpiles and in related media.**

G. GIPLER (Institut für Radiochemie, Dresden) and M. THIEML

*Journal of Radioanalytical and Nuclear Chemistry*, 1994, 183, No 1, 129-145

As part of a wider investigation into the environmental impacts of uranium mining activities in Saxony, radioactive and other inorganic species were determined in mining waters (of different origin) and leachates from medium scale column experiments and batch tests. Uranium concentrations were measured using gamma spectrometry, absorption spectrometry, square wave polarography and inductively coupled plasma mass spectrometry (ICP-MS). For mining waters the uranium concentrations were less than 1 mg per dm<sup>3</sup> except in one case where the level was up to 7 mg per dm<sup>3</sup>. The mining waters were also characterized by neutral pH, high conductivities and high concentrations of sulphate and arsenic, besides their radioactive constituents. Germany

## WATER TREATMENT

95-0759

**Reverse radiometric flow injection analysis (RFIA) of radioactive waste-waters with an ASIA (Ismatec) analyser.**

M. U. J. TOIGYESSY (Yangon University, Myanmar), N. WIN K. SAN, B. HAN and K. M. MYOE

*Journal of Radioanalytical and Nuclear Chemistry Letters* 1994, **187**, No 5, 351-354

Using the ASIA (Ismatec, Switzerland) analyser, a radiometric detector and the reverse RFIA technique, a wastewater sample containing iodine-131 was analysed from the nuclear medicine department of Yangon General Hospital. The analyser had a sodium iodide (thallium) scintillation detector. Peak depth increased with an increase in the injected volume of water in a linear mode.

**International**

95-0760

**Analysis of plutonium in biological and environmental materials.**

Z. HOIGYI (National Institute of Public Health, Prague)

*Journal of Radioanalytical and Nuclear Chemistry Letters* 1994, **187**, No 6, 451-457

A common procedure used for the separation of plutonium from other major elements present in biological and environmental samples (remaining after the combustion of organic compounds) was modified. The new procedure involved adjustment of the oxidation state of plutonium to plutonium(IV) by sodium nitrite in nitric acid medium, coprecipitation of plutonium(IV) with iron(III) hydroxide, separation and washing of the precipitate, dissolution of the precipitate in hydrochloric acid and passing the solution through a strongly basic anion exchange resin. The treatment was tested in model and real conditions. The anion exchanger was used to eliminate interference from thorium-228 and allow plutonium-238 to be analysed. The alpha activity of plutonium-239 and plutonium-240 were measured by liquid scintillation counting. **Czech Republic**

95-0761

**Particulate/solution analysis of radon-226, thorium-230 and lead-210 in sea water sampled by in-situ large volume filtration and sorption by manganese oxyhydroxide**

S. COLLEY (Institute of Oceanographic Sciences, Wormley) and J. THOMSON

*Science of the Total Environment* 1994, **155**, No 3, 273-283

To pre-concentrate radon-226, thorium-230 and lead-210 from sea water, large volume *in situ* pumps were configured first to collect the particulate fraction on 1 µm membrane filters, and second to sorb the dissolved fraction from the filtered stream onto manganese oxyhydroxide impregnated filter cartridges. The results obtained by this method were compared with those obtained for sea water by different sampling and analysis methods. The results for total thorium-230 and lead-210 were in good agreement with theoretical expectations and published results, although the fraction in particulate form was lower, possibly because of a larger filter size. The values for radon-226 were lower and more variable than results in the literature. The sorption of radon-226 by the manganese oxyhydroxide was less efficient than predicted by laboratory studies at neutral pH. There are 36 references. **U.K.**

95-0762

**Boron isotope application for tracing sources of contamination in groundwater.**

A. VENGOSH (Hydrological Service, Jerusalem), K. G. HEUMANN, S. JURASKE, and R. KASHER

*Environmental Science & Technology* 1994, **28**, No 11, 1968-1974

Boron isotope composition was used to trace sewage effluent and contaminated groundwater from the Coastal Plain aquifer of Israel. The boron isotope composition of sewage effluent from the Dan Region Sewage Reclamation Project, Israel, was analysed by negative thermal ionization mass spectrometry. The boron contents and isotopic compositions of raw and treated sewage were similar, indicating that biological treatment had a negligible effect on boron balance and isotopic fraction and did not affect the anthropogenic signature. The isotopic composition of sewage effluent was different to that of uncontaminated groundwater and seawater. Groundwater contaminated with sewage had a high boron to chloride ratio and a distinctive anthropogenic signature. Boron isotope composition could be used as a tracer for the identification and quantification of contaminants in groundwater. There are 39 references. **Israel**

95-0763

**Measuring pH in high-purity water.**

W. F. HARTST (Hartst and Associates Inc., Crystal Lake, Ill.)

*Ultrapure Water* 1994, **11**, No 7, 75-76

Difficulties experienced in determining the pH of high-purity water and techniques adopted to overcome them are discussed. The fundamentals of the hydrogen ion scale are outlined and the use of reagents to match a colour to a pH value is described. The absence in high-purity water of the solids that give a buffering effect in normal waters makes it highly susceptible to sharp pH swings in the presence of a contaminant at even extremely low concentrations; the source of such contaminants is considered. Temperature must also be taken into account. A description of such a meter, including the use of a sealed reference electrode, and its use in line is given. When in-line monitoring was not practicable, the procedure to be followed in ensuring that a grab sample was representative is recommended by the American Society for Testing and Materials is detailed. **U.S.A.**

## WATER TREATMENT

See also Abstracts 95-0654, 95-0704, 95-0705, 95-0706,

95-0707, 95-0708, 95-0709, 95-0711, 95-0712, 95-0713, 95-0714

95-0764

**All part of the process.**

*Water & Environment Management* 1994, No 20, 15-16

Commissioning of Thames Water's Walton water treatment works should be completed by summer 1995. Counter-current dissolved air flotation filter (Coco DAFT) units would be used. Raw water would be passed to ozone contactors. The ozonated water would then be dosed with ferric sulphate coagulant and thence through coagulant contact tanks to enhance flocculation or directly to the Coco DAFT units. In trials up to 90 per cent solids removal was achieved. After post-ozone contactors, the water would flow to granular activated carbon contactors for adsorption of organic matter and oxidation byproducts. Equipment in the existing treatment works would be used for chlorination, dechlorination and ammoniation. **U.K.**

95-0765

**Green book versus red book: a tale of two contracts.**

P. HARVEY

*Water & Waste Treatment*, 1994, 37, No 11, 46 and 48

The same contractor and client used a Red Book (fixed cost) contract for building one water works and a Green Book (costs reimbursable) contract for building another works. The success of either approach depended on the relationship between contractor and client. A wider choice of contract style provided flexibility by introducing variations on both fixed and reimbursable types to suit the client. U.K.

95-0766

**Total dissolved amino acid analysis in natural and drinking waters.**

F. D. BERNE (Ecole Supérieure d'Ingénieurs de Poitiers), B.

PANAIS, N. MERLET, B. CAUCHI, and B. LEGUËL

*Environmental Technology*, 1994, 15, No 10, 901-916 (in French, English summary)

Specimens of raw surface water from 3 French rivers (Oise, Seine and Marne) and water from a treatment plant at Mery sur Oise (Paris) were analysed for the total amino acid content using high performance liquid chromatography after precolumn derivatization with orthophthalaldehyde. The analyses of the water from the treatment plant were carried out at different stages including settlement, flocculation, sedimentation, sand filtration, intermediate ozonation, granulated activated carbon filtration, final ozonation and chlorination. Glycine, serine, alanine, aspartic acid, glutamic acid, threonine and valine were the major compounds analysed at a total amino acid content of 50-250 µg per litre. Seasonal variations in the total amino acid content were noted, with increases being observed in the raw waters during the spring and summer period. The chlorine utilization by the amino acids in treated water was estimated to be 0.4-1 chlorine per litre. There are 33 references. (English translation, 225 pounds sterling, valid for 1995). France

95-0767

**Waste stream recycling: its effect on water quality**

D. A. CORNWELL (Environmental Engineering & Technology, Newport News, Va.), and R. G. LEE

*Journal of American Water Works Association*, 1994, 86, No 11, 50-63

The effect of recycling waste streams produced by drinking water treatment were studied. The waste streams included spent filter backwash water, sludge thickener overflow, sludge lagoon overflow and dewatering liquid wastes. Twenty-four treatment works were surveyed. Potential problem areas were identified as manganese, trihalomethane and its precursors, *Giardia*, *Cryptosporidium* and assimilable organic carbon. These were studied in detail at 6 of the works. In many situations, proper management and treatment of the waste streams could make them suitable for recycling. Recycle streams should be equalized and blended in over 24 h or over the plant's operating cycle if less than 24 hours. Recycle streams should be monitored regularly for the contaminant of concern. *Giardia* and *Cryptosporidium* could be removed by sedimentation. Proper solids removal reduced manganese. U.S.A.

95-0768

**New chlorides for old sulphates.**

A. SIMPSON (Water Treatment Solutions Ltd)

*Water & Waste Treatment*, 1994, 37, No 11, 34

Ferric chloride and aluminium chloride had excellent coagulation characteristics. Research and performance experience showed that

chlorides had advantages over the use of traditional sulphates for water treatment. The material was highly concentrated and contained lower manganese levels. Lower coagulant doses reduced sludge output and sludge treatment and disposal costs. U.K.

95-0769

**Comparison of organic compounds removal by coagulation-flocculation and by adsorption onto preformed hydroxide flocs.**

F. JULIEN (Faculté des Sciences, Limoges), B. GUEROUX, and M. MAZET

*Water Research*, 1994, 28, No 12, 2567-2574 (in French, English summary)

Alum or ferric chloride were used as coagulants in jar tests to flocculate 100 mg kaolinite per litre suspensions to which known concentrations of organic compounds were added under slow mixing conditions. Following equilibrium, the suspension was filtered and analysed. Organic compounds without or with only one functional group were not removed by coagulation/flocculation or adsorption onto pre-formed flocs. Compounds with at least 2 functional groups, principally in the ortho position, were removed by both mechanisms. Iron(III) was the more effective chemical. Anionic species, but not cationic, were removed by pre-formed flocs, clearly by an electrostatic mechanism. The zeta potential corresponding to optimal organic compound removal was not necessarily zero mV and depended on the characteristics of the molecule. (English translation, 220 pounds sterling, valid for 1995). France

95-0770

**The specification of filtering materials for rapid-gravity filtration**

D. G. STEVENSON (University College, London)

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 5, 527-533

The principles and technical background underlying the recently published British Water standard for specification, approval and testing of filtering materials are explained. Terminology, hydraulic grain size, interstitial volume, appearance and shape of material, dirt content, composition, hardness, abrasion and basis for sale are explained. The approach bases the standard on parameters which affect the behaviour of the material during filtration, rather than specifying material composition and appearance. This concentrated on the fundamentals of testing and avoided irrelevant parameters. U.K.

95-0771

**Depth versus sand - filtration techniques on trial.**

G. PEARCE (Kalsep Ltd)

*Water & Waste Treatment*, 1994, 37, No 11, 27

With low capital expenditure and running costs, new depth filters could provide a higher filtrate than sand filters or dual media filters containing sand and anthracite. The systems had low backwash volumes, high flow rate and removal rates. U.K.

95-0772

**Long-term effects of sludge application to land.**

W. S. GERTSMA (Metall & Eddy Pacific Inc., Honolulu, Hawaii), W. R. KNOX, K. J. T. NOVAK, and D. DOVE

*Journal of American Water Works Association*, 1994, 86, No 11, 64-74

A short-term study concluded that alum sludge application had caused no significant adverse effects on groundwater quality or pine tree growth. A follow-up study of long-term effects (30 months)

confirmed this. Soil analysis, soil water monitoring, groundwater monitoring and pine needle tissue analysis showed no statistically significant differences between unamended and sludge-amended sites. Despite the development of acidic soil pH conditions, there was no significant metals migration through the soil or groundwater profile. Sludge application did not cause nitrate contamination of groundwater or soil water. There were no effects on plant-available phosphorus or pine tree growth. Therefore, alum coagulant sludges could be applied to forest lands at loading rates of at least 1.5-2.5 per cent by dry weight. U.S.A.

95-0773

## **Alum sludge land application and its effect on plant growth.**

J. B. LUCAS (North Carolina Division of Environmental Management, Raleigh, NC), T. A. DILLAHA, J. T. NOVAK and W. R. KNOCKE.  
*Journal of American Water Works Association*, 1994, **86**, No 11, 75-83.

The effects of the addition of alum water treatment sludge (loading rates 0-4 per cent), lime and phosphorus on fescue yield and composition were studied in greenhouse experiments. Fescue yields decreased with increased sludge application rate due to a reduction in plant available phosphorus. Higher rate of phosphorus addition could correct the phosphorus deficiency. Although higher sludge loading rates increased manganese and copper levels in the plant tissue, plant growth was not affected. Lime addition did not affect yield. U.S.A.

95-0774

## **The effect of shear on the dewatering of water treatment residuals.**

J. T. NOVAK (Virginia Polytechnic Institute and State University, Blacksburg) and N. BANDAK.  
*Journal of American Water Works Association*, 1994, **86**, No 11, 84-91.

The dewatering behaviour of water treatment sludges (alum and lime sludges) under varying shear conditions, and the influence of shear on the performance of organic polyelectrolyte conditioning sludges were examined in bench scale studies. Unconditioned alum sludges were extremely sensitive to shear. When polymer was added, dewatering response depended on both shear and mixing period. Increasing the polymer dosage reduced sensitivity to shear. Lime softening sludges did not deteriorate when mixed. There was a single optimal polymer dosage of 80-100 mg per litre and polymer conditioned lime sludge was always better than unconditioned sludge. U.S.A.

95-0775

## **Use of plant material for the decontamination of water polluted with phenols.**

J. DEB (Pennsylvania State University, University Park) and J. M. BOELLAG.  
*Biotechnology & Bioengineering*, 1994, **44**, No 9, 1132-1139.

The efficiency of various plant materials (potato, white radish and horseradish) was examined for the removal of 2,4-dichlorophenol from an industrial wastewater contaminated with up to 850 ppm of the compound. Horseradish mediated removal of 2,4-dichlorophenol from the solutions was comparable to that achieved using purified horseradish peroxidase, with the added advantage that the horseradish could be reused up to 30 times. Studies on 2,4-dichlorophenol removal with horseradish indicated that the pH of the reaction mixture, the cut horseradish piece size, the incubation period, and the quantity of horseradish and hydrogen peroxide in the reaction

mixture all influenced substrate transformation. In general, the use of plant material might present a breakthrough in the enzyme treatment of contaminated water. There are 33 references. U.S.A.

95-0776

## **Interaction of metals and protons with algae. 4. Ion exchange vs adsorption models and a reassessment of Scatchard plots; ion-exchange rates and equilibria compared with calcium alginate.**

R. H. CRIST (Messiah College, Grantham, Pa.), J. R. MARTIN, D. CARR, J. R. WATSON, H. J. CLARKE, and D. R. CRIST.  
*Environmental Science & Technology*, 1994, **28**, No 11, 1859-1866.

Sorption of metals on algal cells was treated in terms of adsorption and ion exchange. For algae, sorption of metal ions was accompanied by displacement of other cations and an ion-exchange model therefore more consistent with this system. An ion-exchange constant for zinc displacing calcium from *Rhizoclonium* was used to calculate concentrations over a wide range to assess interpretations given to Langmuir and Scatchard plots. Values of ion-exchange constants for 7 metals displacing calcium from *Vaucheria* correlated with formation constants of the metal acetates and with the exchange constant of the metals on calcium alginate. The desorption rates of metals from *Vaucheria* by EDTA were determined. The removal of cadmium from water with a calcium alginate column was investigated. U.S.A.

95-0777

## **Pilot study of low-temperature nitrification at the drinking water treatment plant in Pont-Ar-Bled (Brittany).**

J. PATRIS (Laboratoire de chimie des nuisances et genie de l'environnement), A. LAPLANCHE, F. SAMMUT, M. M. BOURBIGOT, M. TRIANT, F. JACQ, and J. P. PRIGENT.  
*Techniques Sciences Methodes*, 1994, **89**, No 9, 513-515 and 517-518 (in French, English summary).

Raw water for the Pont-Ar-Bled treatment works (capacity 57 000 m<sup>3</sup> per d) was taken from the Elorn river which had exhibited a progressive increase in the nitrate concentration from approximately 20 mg per litre in 1970 to around 50 mg per litre at the present time. In order to safeguard the quality of the supply to the urban population of Brest, the water was subjected to ion-exchange treatment to reduce the level of nitrate in the finished water to an acceptable level. However, the disposal of the spent regenerant by transporting it to the municipal works for treatment with the incoming sewage became problematical in view of the EC Directive in respect of treated sewage effluents. For this reason trials were carried out with heterotrophic biological denitrification for reducing the nitrate level under low temperature conditions. The temperature of the water normally exceeded 8°C but during the spring could fall to approximately 3-4°C. A pilot plant for biological denitrification was installed consisting of the biological reactor, a sand filter, ozonation treatment, desaturation column and activated carbon filtration. Ethanol was introduced as a carbon source and provision for dosing phosphate and other substances in small amounts was also made. The results obtained during a 2-month trial period in April/May demonstrated that nitrate removal efficiencies in the range 90-100 per cent could be achieved with temperatures varying from 4°C to 19°C using down-flow biological filtration with ethanol dosing. Careful control of the ethanol dose as a function of the incoming nitrate content, with adjustments determined by the TOC at the outlet from the sand filter, was an important condition of successful operation. (English translation 145 pounds sterling, valid for 1995). France.

95-0778

**Denitrification of drinking water - a bioenergetic evaluation.**

M. GREEN (Israel Institute of Technology, Haifa), R. F.

LOEWENTHAL, M. SCHNITZER and S. TARRE

*Water SA* 1994, **20**, No 3, 223-230

Fluidized bed reactors with ethanol as carbon source and electron donor were used to study groundwater denitrification. Average biomass yield was 0.15 g of cells per g of nitrite removed and 0.3 g of cells per g of ethanol removed. These values agreed with most other research findings but were lower than theoretical expectations based on bioenergetic considerations. To investigate possible reasons for the discrepancies, a bioenergetic model was formulated and applied to anoxic processes. Energy requirements for the anabolic component were determined and matched with energy generated in the catabolic processes with due consideration to entropy changes. To obtain agreement between theory and practice, catabolic efficiency had to be reduced to approximately one third of its expected value. Nutrient deficiency conditions, substrate type and toxicity are discussed as possible reasons for the discrepancy. **Israel**

95-0779

**Full of Eastern promise.**

I. TEMPERLEY

*Water Services* 1994, **98**, No 1186, 42-44

Concern over the dangers of chlorination byproducts had caused a reduction in chlorine use and consequently in the bacteriological quality of water supplies. Ozone and ultraviolet light sterilization did not have the residual effect necessary to prevent recontamination in the distribution system. The Electro-Chemical Activation (ECA) treatment process was developed at the Russian Institute for Medical and Scientific Research. It enhanced the chemical activity of the salts and constituent of the water. An electrolytic cell produced nascent chlorine and oxygen which reacted immediately to form chlorine dioxide, ozone and hydrogen peroxide. This combination of bactericides was effective against viral organisms and spore-forming bacteria. The remaining chlorine compounds were decomposed in a catalyst chamber, and short-lived nascent oxygen, chlorine and hydroxyl groups were formed which enhanced the bactericidal effect. The redox potential of the treated water prevented the formation of toxic organochlorine compounds. Hydroxyl ions reacted with heavy metals to form insoluble hydroxides. It required filtration would remove the heavy metal hydroxides. The ECA process was widely used in Russia and was the standard method for sterilizing water for general hospital use. It required no chemical dosing equipment or bulk storage facilities, it only needed electrical power. It had applications in the treatment of potable, waste, industrial, domestic and agricultural waters. **Russia**

95-0780

**Management of the quantity of water in the SFDE distribution system: in-pipe rechlorination.**

P. BONNE (Compagnie Generale des Eaux), J. CAVARD and M. LAMBERT

*Eau Industrie Nuisances* 1994, No 176, 61-64 (in French, English summary)

The introduction of mobile chlorination equipment at strategic locations for the in-pipe chlorination of drinking water supplied is described as part of the water undertaking's strategy for improving the hygienic and organoleptic quality of its supply at the point of use. Instead of using abnormally large doses of chlorine at the exit from the treatment works with the associated problems of taste and odour, the use of rechlorination facilities at selected points provided a

reliable and unobjectionable method of ensuring the maintenance of an adequate chlorine residual. The implementation of this strategy including the location of the rechlorination points within the distribution network for the Ile de France and the nature of the equipment employed are discussed. Sites for rechlorination were selected with the aid of mathematical modelling, remote sampling and bacteriological testing and hydraulic conditions. The equipment was housed inside portable cabins and no more than 500 kg of chlorine could be stored at any location. Automatic detection and neutralization systems to counteract any possible escape of gas were mandatory (English translation 85 pounds sterling valid for 1995). **France**

95-0781

**Degradation of sulphur containing s-triazines during water chlorination.**

G. MASCOLO (I.N.R. Istituto di Ricerca Sulle Acque, Bari), A.

LOPEZ, R. PASSINO, G. RICCO and G. TIRAVANTI

*Water Research* 1994, **28**, No 12, 2499-2506

The reactions of prometryne, terbutryne, ametryne and desmetryne with hypochlorous acid and chlorine dioxide were studied at 20°C and pH 8 over 48 h. In most experiments the initial oxidant and herbicide concentrations were 11 and 3 ppm, respectively. Experiments with 3 ppm/3 ppb and 11 ppb/3 ppb were carried out for prometryne only. Analyses were by high performance liquid chromatography/mass spectrometry. All the compounds reacted in the same way with each oxidant. The hypochlorous acid reactions were faster than those with chlorine dioxide and gave rise to the sulphoxide, sulphone and the latter's hydrolysis product. Chlorine dioxide yielded only the sulphoxide. All reactions were slower at the lower oxidant concentrations. A general pathway for the oxidation of sulphur containing s-triazines is proposed. There are 33 references. **Italy**

95-0782

**Chlorination studies of free and combined amino acids.**

I. HURRIKI (Universite de Poitiers), J. P. CROQUE and B.

LEGUEN

*Water Research* 1994, **28**, No 12, 2521-2531

The chlorine demand, total organic halogen (TOX) and trihalomethane formation potentials of 22 free amino acids, some polypeptides and proteins were determined at pH 8, 20°C, in darkness for 72 h. The chlorine demands of free amino acids were 2.5-16 mol per mol of amino acid. Although contributing little to chloroform production they were characterized by high TOX formation potential (TOXEP). The most reactive contained amino nitrogen, sulphur or activated aromatic rings as side groups. Amide linkages did not participate significantly in the chlorine demand. Sulphite dechlorination before analysis had a slight effect on the determination of TOXEP. With amino acids present in treated water at up to several hundred nmol per litre, their contribution to the chlorine demand of TOXEP of potable water during final disinfection was likely to be significant. There are 30 references. **France**

95-0783

**Degradation of chloroethanes in dilute aqueous solution by hydrogen peroxide/UV**

J. de LAAT (Ecole Supérieure d'Ingénieurs de Poitiers), I.

TACT and M. DORI

*Water Research* 1994, **28**, No 12, 2507-2519 (in French, English summary)

A kinetic model was developed of the reaction of hydrogen peroxide in UV light with an organic compound. It assumed that hydroxyl radicals were the active species causing the degradation, that pho-

## WATER TREATMENT

tolysis of hydrogen peroxide was unaffected by organic or inorganic solutes, and that the steady-state approximation could be used for the concentration of hydroxyl radicals. The model was tested against experimental data for the decomposition of chlorinated ethanes under conditions of different hydrogen peroxide dosage, pH, bicarbonate and aquatic fulvic acid concentrations. No decomposition occurred with hydrogen peroxide or UV irradiation separately. In the presence of UV light, the speed of chloroethane decomposition increased with hydrogen peroxide concentration to a maximum then declined above 0.01 mol hydrogen peroxide per litre. Hydroxyl radical scavengers such as bicarbonate decreased oxidation efficiency, pH above 8-8.5 reduced efficiency but had little influence below this value. An organic background tended to reduce efficiency. For constant hydrogen peroxide concentration, the reaction was pseudo first order. Calculations of second order rate constants for the reaction between hydroxyl radicals and chloroethanes agreed with literature values. English translation 440 pounds sterling, valid for 1995. France

95-0784

### **Oxidation and biodegradability enhancement of 1,4-dioxane using hydrogen peroxide and ozone.**

C. D. ADAMS (Clemson University, S.C.), P. A. SCANLIAN, and N. D. SECORIST

*Environmental Science & Technology*, 1994, 28, No 11, 1812-1818

The use of hydrogen peroxide in combination with ozone to increase the biodegradability of 1,4-dioxane in synthetic groundwater and industrial wastewaters was investigated. The effects of the hydrogen peroxide: ozone ratio, bicarbonate alkalinity, anaerobic metabolic by products, organic wastewater constituents, and initial dioxane concentration on the oxidant dosages required to achieve biodegradability enhancement of the synthetic aqueous solutions of 1,4-dioxane were examined. Bicarbonate alkalinity and competition by 1,3-dioxolane and 2-methyl-1,3-dioxolane increased the oxidant dosages required for 1,4-dioxane oxidation. The optimal hydrogen peroxide: ozone molar ratio was 0.5:1 for most wastewaters. There are 49 references. U.S.A.

95-0785

### **Alternative strategies for removing bromate.**

M. SIDDIQUI (US Air Force Academy, Colorado Springs, Colo.), G. AMY, K. OZEKIN, W. ZHAI, and P. WESTERHOFF. *Journal of American Water Works Association*, 1994, 86, No 10, 81-96

Bromate was formed during ozonation of natural waters containing bromide. Drinking water regulations would probably specify a maximal contaminant level (MCL) of 10 µg per litre for bromate and a best available treatment (BAT) of pH adjustment. Removal options applicable to conventional surface water treatment works using ozone are evaluated. Methods for removing bromate after its formation were: use of a chemical reducing agent-coagulant, activated carbon and ultraviolet (UV) irradiation. The innovative technique of high-energy electron beam (HEEB) irradiation for bromate destruction was also studied. In all the processes, bromide was found in the treated water indicating that chemical reduction was the dominant removal mechanism. The presence of background (DOC) affected bromate reduction for all the processes. pH variation affected reduction by ferrous iron and activated carbon treatment. Ferrous iron, introduced after preozonation acted as a reducing agent for bromate and as a coagulant for disinfection by product precursors. Granular activated carbon columns could be used economically to remove

bromate from low-DOC and chemically pretreated waters. The cost of UV and HEEB irradiation had not been adequately evaluated. U.S.A.

95-0786

### **Effect of water composition on organic micropollutant removal by ozonation: part 2: simulation of micropollutant removal in ideal reactors.**

M. T. ORTA DE VELASQUEZ (Universidad Nacional Autonoma de Mexico, Coyoacan), N. MARTIN, V. BOISDON, and A. LAPLANCHE

*Revue des Sciences de l'Eau*, 1994, 7, No 3, 309-323 (in French, English summary)

A mathematical simulation of trace organic contaminant oxidation in a plug-flow reactor was developed, on the assumption that the concentration of hydroxyl radicals was proportional to the concentration of ozone at any point and that the oxidation process was governed by second order kinetics. The point concentration of ozone was calculated from the partial pressure on the basis of Henry's Law, and also the rate of dissipation of ozone during passage through the ozone contactor, which consisted of a column into which ozone was injected at the base. The simulation was calibrated with reference to experimental observations of the rate of destruction of parathion, and the resulting model was capable of predicting the effects of changes in ozone dosage and contact time on the residual level of parathion with a reasonable degree of accuracy. Further refinements to the model to take into account non ideal conditions at the base of the column are proposed. (see also Aqualine Abstract No 94-5275) (English translation 250 pounds sterling, valid for 1995). Mexico

95-0787

### **Ozone friendly.**

E. STEDMAN

*New Civil Engineer*, 1994, No 1104, Water Supplement 10-11

Brief technical details are given of the introduction of ozonation to the Invercarnie water treatment works, serving Aberdeen, of Grampian Regional Council. The intention was to reduce colour from the peaty source water (the Dee river), to meet EC drinking water requirements and to satisfy consumers' wishes, and also to reduce consumption of chlorine by reducing the chlorine-consuming organic compounds. Air source ozone would be generated on site, and introduced between the raw water storage reservoirs and the first stage of the present treatment (slow sand filtration), via over- and under-baffles in 2 reactors. Final treatment would be, as at present, lime addition for pH correction and chlorination for disinfection. Space had been left at the works for the incorporation of additional or alternative treatments such as lead reduction or chloramination. U.K.

95-0788

### **Part 1 - nanofiltration compared to other softening processes.**

B. W. SCHNEIDER (Schneider Enterprises, Burlington, Wis.)

*Ultrapure Water*, 1994, 11, No 7, 65-68 and 70-74

A detailed survey is presented of alternative methods of softening water, by either excluding the ions constituting its hardness (by membrane processes), precipitating them (by chemical processes), or binding them to suitable materials (by ion-exchange processes). The principal membrane process discussed is nanofiltration, in terms of the pore diameter and shape of the filter material, its formation into spiral-wound elements, its operating pressure, and the percentage (75-95 per cent) of permeate required. The proportion of divalent and monovalent ions that could pass through the membrane into the

permeate at different concentrations of total dissolved solids in the water being treated is considered, and the improvement in solids rejection attainable by the addition of a scale inhibitor or acid before filtration is suggested. Among the precipitation processes, cold and hot lime softening are described in terms of their chemistry and economics, lower initial capital costs were counter balanced by higher operating costs, especially when the treatment and disposal of the softening sludge, with its high water volume, is taken into account. The ability of ion-exchange processes to achieve high levels of softening under suitable conditions is discussed including the ratio of monovalent to divalent cations in the water, and adequate replenishment or regeneration of the ion-exchange materials when they become exhausted. The degree of operator skill required for each type of process is discussed and for each type data are given for typical reductions in total dissolved solids, calcium, sodium, and magnesium. U.S.A.

95-0789

#### Removal of phosphate in aqueous solution by permethylated poly(ethylenimine).

V. PALMER (Universitat Tubingen), R. ZHOU, K. I. GLICKLER, and E. BAYER

*Acta Hydrochimica et Hydrobiologica*, 1994, 22, No 5, 251-257 (in English)

The water soluble polymer, permethylated poly(ethylenimine), or PMP, was obtained by methylation of polyethylenimine using methyl sulphate, as described in the literature. The resulting polymer acts as a complexing agent for phosphate ions because of the positively charged amino groups present in both the polymer backbone and the side chains. The reaction between PMP and phosphate was investigated over a wide range of possible variables as a basis for a selective, homogeneous route for the elimination of dissolved phosphate from water and effluents. By dosing the polymer in the correct proportions into a solution of phosphate containing 500 mg phosphate per litre at pH 8.5, followed by membrane filtration, a 99% removal performance was achieved. The maximal binding capacity of the PMP reagent amounting to 185 mg phosphate per g of polymer at pH 7. Studies of the degree of interference from competing anions indicated that only sulphate ions at high concentrations caused any significant interference. Germany

95-0790

#### Transformation of chlorinated organic compounds by iron and manganese powders in buffered water and in landfill leachate.

C. G. SCHREIER (Stanford University, Calif.) and M. REINHARD

*Chemosphere*, 1994, 29, No 8, 1743-1753

The ability of iron and manganese powders to transform some chlorinated organic compounds under anaerobic conditions was investigated. Tetrachloroethylene (PCE) was transformed by iron powder (4.1 g per litre) in oxygen free, HEPES buffered (pH 7) water at 50°C with a half life of 20 d. At room temperature in oxygen free, HEPES buffered water, 1,1,1-trichloroethane (TCA), 1,1-dichloroethylene (DCE) and PCE reacted with both metals. Dichloromethane (DCM), 1,1-dichloroethane (DCA) and 1,4-dichlorobenzene (DCB) did not react with either metal. TCA was completely transformed within 28 d. DCE and PCE were 80 and 55 per cent removed, respectively. The reaction of the chlorinated organic compounds at room temperature in autoclaved buffered solution was compared to their reaction in 2 non autoclaved leachates from 2 landfills. When iron was added to the 2 leachates

the reactivity was similar to that seen for the room temperature HEPES experiment with iron. The reactivity of the 6 substrates in the presence of manganese was similar in the 2 leachates. The concentration of TCA decreased, that of DCA increased and DCM, DCE and DCB did not react. PCE disappeared from one leachate but not the other. Biological transformation was seen in one leachate. U.S.A.

95-0791

#### Kinetics and products of TiO<sub>2</sub> photocatalytic degradation of pyridine in water.

C. MAILLARD DU PUY (Ecole Centrale de Lyon, France), C. GUILLARD, H. COURBON, and P. PICHAT

*Environmental Science & Technology*, 1994, 28, No 12, 2176-2183

Pyridine solution at 6.165 mM was equilibrated with titanium dioxide in the dark then exposed to UV light. Analyses were by high performance liquid chromatography and gas chromatography/mass spectrometry, the latter especially for intermediates. Pyridine initially disappeared according to first order kinetics at a rate swifter than benzamide. A phenylethanamide and nitrobenzene. Hydroxylation occurred at the second position. Acetate, formate and 2-aminophenyl intermediates were identified, all containing carbonyl groups and in some cases an amide group. For relatively high initial pyridine concentrations, dipyridyl and carbamoyl pyridine isomers were also detected as intermediates. Organic nitrogen was almost totally mineralized at UV irradiation times 2.5 times as long as required to eliminate pyridine. France

95-0792

#### State of development for process water and effluent treatment in hot-rolling mills: design and operating results for a new water circulation system

L. DAMMANN (Consulagua Hamburg) and U. GRABBE

*Korrespondenz Abwasser*, 1994, 41, No 10, 1820-1822 and 1824-1826 (in German, English summary)

A new water and effluent treatment system was introduced by the Klockner steelwork for its hot-rolling machine shop in March 1992. The cooling water was treated and recirculated at a rate of 18 000 m<sup>3</sup> per h, and the recycling process permitted a reduction in the overall water consumption for steelmaking to about 62 m<sup>3</sup> per tonne from the original figure of 90-100 m<sup>3</sup> per tonne. The water underwent coagulation, and flocculation followed by dual media filtration before being recycled, the sludge first being thickened and then dewatered in a filter press prior to disposal. The layout and detailed plant descriptions for the entire treatment and recirculation plant, together with compositional data on the recycled water and the sludge, are repeated. (English translation 270 pounds sterling valid for 1995). Germany

95-0793

#### Reverse osmosis versus ion exchange - part I

B. HAMILTON (Hamilton Engineering Inc., Denver, Colo.) and D. DRIMMONDS

*Utahpure Water*, 1994, 11, No 2, 22-33

A comprehensive review is offered of the advantages and disadvantages of ion exchange and reverse osmosis processes for the production of high purity water. Operational factors that should be evaluated before a decision on which to select is made are reviewed. A thorough knowledge of the characteristics of the raw water, especially the level of total dissolved solids, was required to select the appropriate process. Technical factors leading to the most effi-



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cient use of each method are considered including water temperature range (broad for ion-exchange, narrow for reverse osmosis), the need for pH correction (greater for cellulose acetate membranes than for thin-film composite polyamide), pre-treatment requirements, the sensitivity of membranes to attack by either bacteria or the chlorine used to control them, and the proportion of feedwater eventually appearing as waste (typically 10 per cent for resin regenerant, 25 per cent for membrane reject water). The problems of chemicals storage, especially for resin regeneration and restrictions on waste disposal imposed by health-related and environmental regulations are considered. Capital and long term operating costs should be considered including life expectancy of resins and membranes, regeneration costs (on site or off site), consumables (especially power for pressurizing membranes), the need for back up when either process failed or was taken out of service for maintenance, and locally operative factors at any one site. U.S.A.

95-0794

**The role of membrane technology in water purification systems for reactivated variable-load power plants.**

W. V. COLLENTRO (Water Consulting Specialists Inc., New Hope, Pa.)

*Ultrapure Water*, 1994, 11, No 7, 40-46

High purity water treatment to provide boiler make up water at power stations used intermittently are discussed. The situation postulated is that of a de-commissioned power station, with its original water treatment process and of comparatively small generating capacity. Four alternative treatments, all based on membranes of different types used in various configurations, reverse osmosis, ultrafiltration, and electrodialysis reversal are suggested. The choice would depend on the particular circumstances of each individual power station. U.S.A.

## UNDERGROUND SERVICES AND WATER USE

See also Abstracts 95-0501, 95-0646, 95-0688, 95-0893

95-0795

**The use of plastic pipes in the water industry.**

J. MORRIS (WRc plc, Swindon)

*Pipes & Pipelines International*, 1994, 39, No 5, 37-38

The 3 principal types of plastic pipe used in water industry applications are described: polyethylene, PVC, and glass reinforced plastic. Characteristics and advantages of these different materials are discussed together with their applications. Work carried out by WRc plc in investigating plastic pipes and developing standards for the U.K. water industry is outlined. Issues addressed during this work included jointing conditions, fracture, pipeline components, installation and pipeline performance, and operating costs. U.K.

95-0796

**Flygt path**

R. BYLES

*New Civil Engineer*, 1994, No 1104, Water Supplement, 21-22 and 24

The range of services offered by IFF Flygt is expounded. The company, while primarily known as a supplier of pumps (especially submersibles), also offers a design service for pumping stations and for water treatment and sewage treatment works. Fewer problems

arise in integrating the civil, mechanical and electrical elements of an engineering scheme when the mechanical and electrical contractor supervises the civil work rather than when the situation is the reverse. Examples of recent contracts in the U.K. are quoted. U.K.

95-0797

**Network modelling: advances at a major British utility.**

A. ELTON (Severn Trent Water Ltd, Birmingham), and A. M. SCHULTE

*Journal of American Water Works Association*, 1994, 86, No 11, 32-39

Severn Trent Water had been involved in dynamic network modelling for more than 13 years. An analysis of the benefits of network analysis showed that extra customer-related benefits could be realized by extending the use of network models to nonspecialists. The network analysis capability was expanded to the operating districts. This required enhancement of the software, provision of hardware and network models, and user training. The economic benefits achieved during the first 3 years of the models' use outweighed the initial investment. U.K.

95-0798

**Misslon control.**

M. HADDON

*Water Bulletin*, 1994, No 629, 11-12

A brief description is offered of the supervisory control and data acquisition system installed at the Hampton water treatment works by Thames Water to ensure the most cost effective operation of its London ring main system. Information on volume of flow, pressure, reservoir levels, turbidity and chlorine levels is integrated into operational data from 7 major treatment works, 26 wells, 76 service reservoirs, 9 re-pumping stations, and 11 pump out shafts. Although the main is gravity fed, power is required for pumping out to supply districts, and for re-pumping within the ring itself, optimizing the time of pumping to take advantage of favourable electricity tariffs requires a knowledge of the demand patterns of individual supply districts, and likely modifications of them when weather conditions change customers' demand habits. Adjustments to flow in the ring have also to be made when repair and maintenance are required to any part of it, or to any of the works feeding it. U.K.

95-0799

**New York TBM.**

J. BURKE

*World Tunnelling*, 1994, 7, No 8, N9 and N11-N12

The use of a TBM in the excavation of water tunnel projects in New York City is described. The Robbins TBM was being used for boring 29 000 ft of 24 ft and 20 ft diameter tunnel. After driving 4 short tunnels, the machine was rebuilt with new cutters and additional thrust capacity. Excavation through the difficult ground conditions is discussed. Design and operation of the Lake Shore vertical conveyor is also outlined. U.S.A.

95-0800

**Yalding's yield bears fruit in Garden of England.**

I. M. R. FAWDRY (McDowells Ltd)

*Water Services*, 1994, 98, No 1184, 12-13

The almost completed Southern Water Yalding Water Resource scheme at Bewl Water near Tunbridge Wells would increase the yield from the Medway river basin, the major source of surface water in the county. The pipeline contract awarded to R. E. Dacwra is described. The contract comprised laying 1200 mm diameter steel

pipe buried on a 19 km long route through Kent countryside. The pipes and fittings were internally lined with centrifugally applied cement mortar and externally coated with bitumen enamel wrapping. An impressed current system of cathodic protection had also been installed at several locations along the route to cope with aggressive soil conditions. Environmental considerations involved in the pipelaying project are discussed. U.K.

## 95-0801

### Experience of cement mortar-lined steel pipe for conveyance of soft aggressive water from an impounding reservoir.

M. GIERIG (Bayerisches Landesamt für Wasserwirtschaft München), G. SCHRETZENMAYR, and W. SCHWENK. *GWF Wasser/Abwasser*, 1994, 135, No 10, 573-576 and 578-580 (in German, English summary).

Various types of cement mortar lining for steel water mains were subjected to field trials lasting 8 years, during which time they were continuously exposed to the soft aggressive water from a reservoir. The water composition was on the borderline for the use of normal mortars according to DIN 2614. After a period of 4 years the formation of a biofilm with a coating thickness of up to 3 mm was observed, accompanied in some cases by enhanced corrosive attack on standard mortars for which the localized production of carbon dioxide was believed to be responsible. Special grades of mortar with acid resistant properties were virtually unaffected, with lower levels of film formation and negligible corrosion. The presence of organic additives in the mortars did not have any undesirable effects. The presence of humic acids in the water, however, was partly contributory to the deterioration of the lining, owing to their utilization as a substrate by organisms responsible for biofilm growth and production of carbon dioxide in the biofilm. (English translation 205 pounds sterling, valid for 1995). Germany

## 95-0802

### Material gain.

J. MANSON. *Water Services*, 1994, 98, No 1184, 14-15.

A new plastics alloy pressure pipe system, Hep30, had been developed by Hepworth Industrial Products following a 3 million pound sterling, 5 year rolling investment programme. The system offered significant performance, life costs and reliability benefits over polyethylene and ductile iron. The new pipe was the result of collaboration between Hepworth Building Products, North West Water and the consultancy Pipeline Developments. Testing regimes had involved both U.K. experts and organizations in Europe and the U.S.A. The plastics alloy was formed by blending chlorinated polyethylene, polyvinyl chloride and selected acrylic derivatives. The material had exceptional resistance to cracking, long term strength retention, high impact resistance and high protection against cycle loading fatigue. Following 3 years of successful trials, the material had been selected by North West Water for most of its trunk main applications. U.K.

## 95-0803

### To sleeve or not to sleeve?

M. HOFFMAN (Stanton Plc). *Water Services*, 1994, 98, No 1186, 40-41 and 46.

Zinc and zinc alloys had excellent corrosion resistance and were used as protective coating for iron and steel. Zinc formed a protective layer of transformation products and, being electronegative to iron, could protect it sacrificially. In Europe, zinc coating had been applied to ductile iron pipes for more than 30 years. In the U.K., polyethylene

sleeving was used to protect ductile iron mains. Zinc coatings were introduced in the U.K. in 1984 and used in conjunction with sleeving. The performance of the coatings in the U.K. and Europe confirmed their suitability as stand alone protection in most cases, thus eliminating the need for sleeving except for particularly aggressive soils. U.K.

## 95-0804

### Water mains inspection using electronic measurement and data storage equipment.

C. HENTKER (Herman Sewerin GmbH). *GWF Wasser/Abwasser*, 1994, 135, No 10, 581-584 (in German, English summary).

An improved system of leak detection is described based on the automatic measurement of noise levels during a selected time interval, say from 02.00 to 02.30 h, when consumption was expected to be minimal and leak noise would be most noticeable above the background noise level. A microphone and data logger in a compact case could be inserted into several valve chambers and left overnight. The following day the stored information could be downloaded into a PC and evaluated. By using a series of measuring points any change in the noise level from point to point would provide some indication of the position of a leak, and more precise localization using a correlator became feasible. Where no leaks were present the background noise levels could be stored for future reference. The benefits of the proposed method relative to more traditional approaches such as measurement of night time consumption are discussed. (English translation 135 pounds sterling, valid for 1995). Germany

## 95-0805

### Loss adjusters.

I. STEDMAN. *Water & Environment Management*, 1994, No 20, 12-13. The EU's Sprint programme helped countries trade technical expertise. Haste Kirkpatrick, in collaboration with Yorkshire Water Services, received project funding to provide technologies such as network modelling and leakage control to 4 utilities in Greece, Spain and Eastern Germany. Europe

## 95-0806

### Localizing difficult leaks.

K. ROY (Rcten Acoustics). *Water & Waste Treatment*, 1994, 37, No 11, 16. Variations in soil density, noise frequency and the non-linear sensitivity of the human ear were some of the problems of traditional leak detection methods. A broad band statistical analysing unit, Aqualog 50, was developed. Using the unit overnight, an approximate area of leakage could be identified. U.K.

## 95-0807

### Sieving the evidence on leakage.

C. FRANCIS. *Water & Waste Treatment*, 1994, 37, No 11, 18. Leakage could be caused by deterioration due to age, ground movement, water pressure changes, adverse ground conditions, damage by third parties and poor workmanship. Pipe joints, fittings and service connections were the most vulnerable areas. Leak location had improved since the introduction of district metering areas. Total leakage ranged from 4.4-16 litres per property d with 14-48 per cent attributable to supply pipe leakage. Many water companies had leakage control departments. Recent reduction of the K factor could affect capital investment schemes. Replacement might be a better

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option than refurbishment on small sized distribution pipelines. It was impossible to eliminate leakage entirely. U.K.

95-0808

### Pressure dependent leakage.

J. MAY (Pro Aqua Systems)

*World Water and Environmental Engineering* 1994, 17, No 8, 10  
Pressure control is fundamental to any leakage control policy. The accurate and stable control provided by Pressure Guardian, an electronic target node pressure control system from Pro Aqua Systems, is described. Results obtained using the system on a distribution system comprising 2972 properties are discussed. The control system utilized the pressure dependent leakage equation, with displayed results showing the equation being applied to show system boundaries and performance. U.K.

95-0809

### Going where no man has gone before: robots take on dangerous underwater pipeline inspections

B. SHERWOOD (Aquatic Sciences Inc., St. Catharines, Ont.)

*Water & Wastewater International* 1994, 9, No 5, 48 and 50-52  
New applications of remotely operated vehicles (ROV) are reported and include internal pipelines and tunnel inspections. An example is given of its use in freshwater mussel control in the Great Lakes region. The system safely replaced divers for the inspection of confined pipelines. Further developments of ROV are identified including sonar imaging, fibre optic umbilical cables and laser range gate imaging. Canada

95-0810

### Aqueduct management planning: Thirlmere, Haweswater and Vyrnwy aqueducts.

R. F. CRITCHLEY (North West Water Ltd.) and D. J. ALKMAN

*Journal of Institution of Water and Environmental Management* 1994, 8, No 5, 502-512

Three of North West Water Limited's largest aqueducts were examined in 1988-1992 to assess their condition and rehabilitation requirements. Among the techniques employed were thermal surveys to detect global leakage, leak noise correlation, a Pearson survey of siphons to identify coating defects, ultrasonic thickness measurement, radiographic inspection, man entry and CCTV surveys, and structural examination of bridges. Where direct inspection was impossible, ultrasonic and CCTV methods were reasonably successful. A 5 category grading system relating to the probability of failure was devised. Historical data were examined. Cast iron pipes were in the best condition, lead jointed steel pipes, prestressed concrete pipes and prestressed concrete bridges were in poor condition. Fabrication and construction difficulties were often at the root of the problems with many older cast iron/steel bridges and valves badly deteriorated. Urgent work was in hand and long term investment plans were being formulated. A discussion on the paper is included. U.K.

95-0811

### Ventilation scheme for the Hamburg trunk sewers

J. LENZ (Umweltbehörde der Freien und Hansestadt Hamburg)

*Abwassertechnik* 1994, 45, No 5, 28-30 (in German)

The problems associated with the generation and emission of foul odours within the Hamburg sewerage system are discussed. The problem had been exacerbated by the construction of the system of deep level interceptors conveying foul sewage from the inner city network to the new central sewage treatment plant at Kohlbrandhoff

Dradenau. The very long transport times and the numerous drop shafts and transfer points between the old and the new sewer systems had accentuated the liberation of those foul-smelling substances which accumulated due to the very slight falls (sometimes reversed) which characterized the older portions of the network. The increase in turbulence in the vertical shafts combined with the flushing effect in response to rainfall events, and also in a few places, the effects of solar radiation on pipe bridges, caused the malodorous substances originally present in solution to be volatilized into the sewer and at some places into the local environment. The legal constraints applying to the atmospheric emission of noxious substances in North Rhine Westphalia are summarized, according to which a threshold value for the concentration of foul odours might only be exceeded for a very limited period. The efforts being made to comply with the official stipulations are reviewed, including measures to arrest the formation of odours (avoidance of septic conditions), structural improvements to minimize their release, and a ventilation system for the entire trunk sewer network. This is composed of 3 sections and a description of the proposed arrangement of exhaust ducts and biofilters for exhaust air fumigation is given. (English translation 165 pounds sterling, valid for 1995). Germany

95-0812

### The Cologne Sewer Scheme 2000 - a half-time report

H. OLLMAN (Amt für Stadtentwässerung Köln) and O.

SCHAAI

*Abwassertechnik* 1994, 45, No 5, 51-54 and 56-57 (in German)

Progress achieved with the implementation of the wide ranging sewerage improvement programme for the city of Cologne is reviewed. The programme, originally commenced in 1987, was due to have reached its half-way point at the end of 1993 and this turning point was marked by the occurrence of an exceptional flood event in the Rhine, which inundated the bankside areas of the city. The first priority of the programme was to update the sewage treatment facilities for the city and to provide tertiary treatment facilities for all the sewage entering the Stannheim sewage treatment plant. This was achieved by the end of 1992, with the result that there had been a significant fall in the pollution load entering the Rhine, although process optimization was still going on at the beginning of 1993. Evidence of the pronounced reduction in nutrient loadings in the treated effluent during the early part of 1993 is presented. Further major works in progress are reviewed, in particular the construction of barrier gates inside the principal effluent outfalls activated in the event of a given high water level in the Rhine being exceeded, to prevent flood waters from entering the sewer network. A sophisticated control network for measurement of upstream flow conditions, rainfall intensity and other relevant factors was also being installed to control the operation of such barriers and sewage pumping stations. Other projects concerned with stormwater retention facilities and domestic property drainage were pending. (English translation 225 pounds sterling, valid for 1995). Germany

95-0813

### Drainage from highways and other paved areas: methods of collection, disposal and treatment.

J. STARTIN (Sir William Halcrow and Partners Ltd, Swindon)

and R. V. LANSDOWN

*Journal of Institution of Water and Environmental Management* 1994, 8, No 5, 518-526

Methods of collecting road drainage by gully, V-shaped channel combined kerb/drainage and grated channel systems, and attenuating flow in on stream and off-stream retention ponds are described

Methods of controlling water quality are considered. Primary sedimentation in oil interceptors or retention ponds could be further enhanced by vegetative treatment systems to encourage sedimentation, to act as filters, bioaccumulate pollutants and fix heavy metals into sediments in the rhizosphere. It is important to consider minimal retention periods and maximal flow velocities rather than concentrate on minimal storage volume alone. The size of the permanent wetted vegetated area should be as large as possible to encourage immobilization and destruction of pollutants. More research is needed to provide design criteria. U.K.

95-0814

## Approaches to parallel storage computations for sewer networks.

R. TANDLER (Computer Tandler, Buch am Erlbach)

*Korrespondenz Abwasser*, 1994, 41, No 10, 1750-1752 and 1755-1761 (in German, English summary)

Previously the behaviour of storm sewer networks during storm events, and the frequency of occurrence of surcharging and back-up in the network, had been estimated by hydrological methods. More recently the new European Standard EN752, had advocated the use of hydrodynamic simulation methods which were very demanding in their use of computer time and also in the level of involvement by the user, especially for complex networks. In addition, an exact determination of overflow frequency required an analysis of very many rainfall events, taking into consideration their place in the sewers. To simplify the method, proposals are made based on the use of the symmetry principle coupled with a microcomputer and several processors, which enabled the desired result to be achieved much more rapidly and with greater economy of effort. (English translation 455 pounds sterling, valid for 1995). Germany

95-0815

## Application of geographic information systems to sewer network calculation.

I. FUCHS (Institut für technisch-wissenschaftliche Hydrologie, Hannover), C. MAKSIMOVIC, D. PRODANOVIC, and J. ELGY  
*Korrespondenz Abwasser*, 1994, 41, No 10, 1766-1768 and 1770-1773 (in German, English summary)

Initial results are reported from a study of the application of GIS mapping to the analysis, design and management of urban drainage networks. The interest lies in the nature of the interaction between different information sources, and the combination of geographic information with the use of sewer system models. The results were part of a project investigating the needs and solutions for a largely automated system of input data acquisition together with the necessary aids and the requirement for further manual processing, as a basis for input to simulation models. Furthermore, the relevant interfaces were being devised to facilitate the preparation and processing of the mapping information. (English translation 290 pounds sterling, valid for 1995). Germany

95-0816

## Cost saving in sewage disposal.

K. BUCKSTEEG (Bayerisches Staatsministerium für Landesentwicklung und Umweltfragen, München), and E. ENGLMANN

*Korrespondenz Abwasser*, 1994, 41, No 10, 1783-1784 and 1787-1788 (in German, English summary)

The need for minimizing the costs of sewage disposal has become one of the major topics of discussion in the context of finance for public utilities. The many proposals for low-cost sewerage systems

often were associated with other cost penalties which might fall on the property owner or occupier, with the result that the overall saving was minimal. Various options for cost reduction in the provision of sewerage facilities are outlined against the background of effluent taxation and standardization of numerous essential components of the sewage treatment system. Some of the professional associations and official bodies involved in efforts to reduce the cost of building and maintaining the necessary facilities are enumerated. Closer attention must be given to the consequences of proposed economies in the short, medium and longer term. (English translation 180 pounds sterling, valid for 1995). Germany

95-0817

## Water in the Emscher, the cooperative drainage undertaking and the local environment.

D. LONDONG (Emscher-Genossenschaft und Lippeverband, Essen)  
*Wasserwirtschaft*, 1994, 84, No 9, 446-450 (in German, English summary)

The drainage problems that had plagued the Emscher district, in the heart of the Ruhr industrial region, since the turn of the century are reviewed. Provisions for sewerage and pipelines for effluent disposal in the catchment were hampered by repeated subsidences due to coal mining, and resulted in the development of stagnant pools and swamps which blighted the whole area. The Emscher-Genossenschaft, the cooperative drainage authority established to deal with these problems, constructed a network of open drains conveying the mixed effluents to a decentralized treatment plant, as a result of which the Emscher became a conduit for all manner of discharges rather than a natural watercourse. With the cessation of much of the industrial activity in the region, and the closure of the deep mines, the subsidence problems no longer arose and the establishment of an underground drainage system became feasible. At the same time foul sewage and effluent discharges had been segregated from stormwater runoff and the restoration of the area had become a high-priority task. Some examples of the application of the latest ecological attitudes to the design of drainage networks, and the renaturalization of watercourses are discussed. These measures had incurred considerable capital expenditure, as a result of which charges for sewerage services had risen substantially. (English translation 205 pounds sterling, valid for 1995). Germany

95-0818

## Sub-surface work for Belfast sewerage job.

P. DARRING

*Tunnels & Tunnelling*, 1994, 26, No 10, 26-28

Work being carried out on Stage 1 of the Duncruie Street Sewage treatment Works inlet trunk sewer in Belfast is described. The work involved the underground construction of a 3 m diameter lined sewer tunnel to replace an old 1.8 m diameter steel line and was carried out by contractor WAM (GB) Ltd. Excavation was by traditional cut and cover methods and by shield, and using different concrete raft support systems to cope with variable ground conditions. Dewatering during excavation is also discussed. The project was started in October 1992 and was scheduled for completion in December 1995. U.K.

95-0819

## Beyond the trenches.

H. DEER (Metcalf & Eddy International, Oxford, S.C.)

*Water Environment & Technology*, 1994, 6, No 11, 50-54

Alternatives to conventional open trench construction for sewer construction are described. Advantages and disadvantages of micro

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tunnelling and horizontal directional drilling are discussed. Alternative rehabilitation techniques for existing pipes are considered. Two examples of rehabilitation in Dubai are summarized. U.S.A.

95-0820

### **Cleveland's West Leg Interceptor**

R. J. ESSEX (Woodward Clyde Consultants) and J. A. MORRISON

*World Tunnelling* 1994, 7, No 8, N13-N20

Excavation work on the West Leg Interceptor Project in Cleveland, Ohio, is described. The interceptor was part of a 15 year programme to construct 46 miles of new interceptors and convey flows from 4 decommissioned wastewater treatment works to the new Southerly treatment works via the new Southwest Interceptor. The West Leg Interceptor included 5.7 miles of deep mainline interceptor tunnel, 1.3 miles of shallow tunnelled connector sewer, 1.8 miles of open cut connector sewers and 5 construction shafts. Geologic conditions and design consideration of the project are discussed. Excavation and tunnelling work by Lovat shield machine equipped with hydraulic flood doors and by TBM equipped with an articulated shield is described. U.S.A.

95-0821

### **Sea-water infiltration: the dramatic corrosion of ductile-iron rising mains.**

M. J. LONG

*Journal of Institution of Water and Environmental Management* 1994, 8, No 5, 538-545

The cause of the repeated failures of a ductile iron sewage rising main at Cowes, Isle of Wight, after only 3 years' service operating at less than 10 bar pressure was investigated. CCTV examination and direct observations demonstrated straight cracks along the top of the pipe, with a series of conical pits internally. Sewage analysis demonstrated from the high chloride and sulphate concentrations that 27-60 per cent of the sewage was sea water. The combination of sulphate reducing bacteria, the high level of sulphates, and air entrained as microbubbles or released from solution created a corrosive environment. Pipes lined with sulphate resistant cement mortar would probably be more durable. The existing pipes were lined with close fitting high performance polyethylene liners to arrest further corrosion. U.K.

95-0822

### **Hydraulics of corrosive gas pockets in force mains**

T. M. WALSKE (Wilkes University, Wilkes-Barre, Pa.), T. S. BARNHART, J. M. DRISCOLL and R. M. YENCHA

*Water Environment Research* 1994, 66, No 6, 772-778

Predictive methods for identifying where hydrogen sulphide corrosion was likely to occur in sewer force mains are presented. The research was conducted following problems with hydrogen sulphide corrosion in sewer force mains operated by Wyoming Valley Sanitary Authority, U.S.A. A physical model of a force main with several peaks was constructed to study the behaviour of hydrogen sulphide pockets in the pipe. Gas pockets occurred in force mains for 2 reasons: (1) air could enter the pipe through an air release or vacuum breaker valve when the hydraulic grade line drops below the pipe levels leading to free surface flow; (2) when buoyancy of the gas pocket prevented the pocket from being dragged downstream and the velocity of the flow prevented buoyancy from moving the pockets upstream to an air release valve, leading to multiphase flow. Equations were developed to predict both types of flow. The resulting equations were applied to the Wyoming Valley Sanitary Author-

ity system. Free surface flow gas pockets were the primary reason hydrogen sulphide corrosion occurred in these force mains. Design and operational steps to prevent force main failures due to hydrogen sulphide corrosion are presented. U.S.A.

95-0823

### **Geophysical investigation of a sewer.**

J. ZINNECKER (Umweltbehörde der Freien und Hansestadt Hamburg)

*Abwassertechnik* 1994, 45, No 5, 10-12 and 14 (in German, English summary)

The importance of obtaining a complete picture of the structural condition of a sewer in need of rehabilitation is stressed, which includes some indication of its load bearing capacity and how it may have been affected by ground conditions, including the presence of voids in the vicinity of the pipe. Such an investigation could only be performed by geotechnical methods which were capable of detecting defects in the sewer wall and the surrounding soil. The range of techniques available is discussed and their chief characteristics identified, comprising gravity meters, geomagnetic measurements, seismic surveys, radiological methods and geoelectric studies. The problems and situations which these methods are capable of identifying are reviewed, and a case study is presented involving the inspection of a deep level masonry sewer of asymmetric cross section in the harbour district of Hamburg. The sewer inspection contract was awarded to 2 different firms, involving a total length of 150 m, with a 25 m overlap between the 2 parts. Both firms employed georadar survey equipment, one using a frequency of more than 750 MHz and the other 500 MHz. The results obtained by both methods are compared, although differences in the mode of presentation in the 2 cases made direct comparison difficult. Examples of the form of output provided by the 2 surveys are given. (English translation 150 pounds sterling, valid for 1995). Germany

95-0824

### **Maintenance of sewer pipelines on a systematic basis**

R. P. ANGSTMANN

*Abwassertechnik* 1994, 45, No 5, 45-47 (in German)

The importance of adopting a systematic plan of sewer system inspection and maintenance, as outlined in the ATV Guidance Document M 147 is emphasized, to insure that every part of the network was inspected at regular intervals, preferably at least once in 10 years. Other factors besides an absence of leakage, such as hydraulic performance, structural condition and extent of corrosion must be taken into account. To implement an effective rolling programme of sewer maintenance, the use of up to date information processing equipment was essential together with accurate mapping systems for pinpointing the location of sewers and other equipment at ground level. These tasks were best performed using LDP equipment, which could assist in the prediction of those parts of the network urgently in need of repair. A conversion from a purely reactive approach to the repair of damaged pipes, or similar forms of remedial work, to a properly planned system of preventive maintenance was a necessity for the preservation of valuable underground assets. (English translation 135 pounds sterling, valid for 1995). Germany

95-0825

### **Hundredth anniversary of the Magdeburg sewer siphon.**

U. FOERSTE, H. J. POSCHKE and M. SCHUTZ

*Abwassertechnik* 1994, 45, No 5, 58-60 (in German)

The city of Magdeburg had been noted for its dual siphon pipe crossing conveying sewage across the Elbe river. These 2 pipes of

1050 mm diameter were originally installed in September 1894 and were of cast iron and steel construction, the steel pipe being situated in the bed of the river and the cast iron sections forming the inclined portions on either side. The Federal Waterways and Navigation Authority initiated a thorough programme of inspection to determine the condition and mechanical integrity of the repairs, this comprised several stages. The pipe was first cleaned by high pressure fitting to remove coarse solids and also fat deposits which had accumulated in the abutting chambers. Preliminary inspections were performed by divers who identified some evidence of damage to joints in the joining cast iron pipe, and this was followed by underwater surveys to ascertain the depth of the pipes below the bed of the river, and also the bed profile at a distance of 10 m in the upstream and downstream directions. In addition, wall thickness measurements were performed on the steel pipe sections and samples of the steel were taken from the crown of the pipe for chemical and metallurgical analysis. Stress analyses were also carried out, based on measurements of the extent of deviation from a true circular cross section. The examination confirmed the siphon to be sound and leak free, although some pipe renovation would be desirable. The annual loss of wall thickness due to abrasion was less than 0.1 mm. (English translation 120 pounds sterling, valid for 1995) **Germany**

95-0826

**Comparison between test methods employing air or water pressure for sewer pipelines**

H. F. O. Bayerisches Landesamt für Wasserwirtschaft München and E. MEISSNER

*Abwasser*, 1994, 41, No 10, 1740-1749 (in German, English summary)

Hydraulic pressure testing of sewer pipes according to DIN 4033 had been the recognized method of leak detection in Germany for many years. Recently the development of a European standard based on the use of compressed air had prompted the application of this method on a trial basis and also the initiation of a research project sponsored by the Bavarian provincial authority for comparing the effectiveness of the 2 methods. The results of the preliminary tests reported, indicating that broadly similar conclusions were obtained from both methods regarding the presence or absence of a leak. The relationship between the physical size of the leak in the pipe and the volume of water or air required to maintain the test pressure was considered, showing only slight differences between the 2 methods. However certain modifications in the approved method of testing using air pressure appeared desirable, particularly in the choice of test pressure and the duration of the test. (English translation 120 pounds sterling, valid for 1995) **Germany**

95-0827

**New CCTV pipeline inspection system to become industry standard, says Pearpoint.**

*Water & Wastewater International*, 1994, 9, No 5, 59

A new generation of closed circuit television pipeline inspection equipment available in PAL or NTSC standard is reported. The P400 Series (Pearpoint Ltd, Bordon) meets key European safety standards and comprises explosion proof cameras, light heads and tractors. Mechanical flameproofing is included. Design advances and advantages of the new system are identified and include a curved camera lens to ensure focus of vision and a range of brushes and skids to ensure centralization of the camera in pipes of different diameters. **UK**

95-0828

**Environmentally-sensitive technologies for rehabilitation of leaking sewers: review of the project presentation for the Federal Ministry of Research and Development.**

D. F. HERMAN (Kernforschungszentrum Karlsruhe) and S. VOLLMER

*Abwassertechnik*, 1994, 45, No 5, 7-8 (in German)

The serious extent of deterioration of underground sewer pipes in Germany is outlined, particularly in the newly designated provinces where around 50 per cent of the total length of 35 000 km was faulty on the basis of a survey by the ATV for the original (western) provinces the situation was less acute, although from 15 to 20 per cent of the total length of 300 000 km was in need of repair. The scope of the Federal R and D project designed to provide remedial measures to rectify the situation is outlined and 6 major objectives are enumerated. Within the general framework of this programme some 180 specific projects had been authorized, and were concerned with the 4 topics of surface detection methods for leaks in buried pipes and sewers, leak testing methods for checking the integrity of sewer pipes, *in situ* damage classification and assessment procedures, and methods of rehabilitation. Some of the particular aspects already being investigated under these headings are reviewed. (English translation 120 pounds sterling, valid for 1995) **Germany**

95-0829

**Replacement of a sewer pipeline using the semi-trenching\* system**

U. KARNAITH (Umweltbehörde der Freien und Hansestadt Hamburg)

*Abwassertechnik*, 1994, 45, No 5, 15-16 (in German, English summary)

A method of installing a new sewer pipeline in place of an older masonry sewer of small internal dimensions is described which reduced the disturbance associated with trenching by reducing the width of the excavation. The method is illustrated with reference to a project to renew a 1 km length of an old oval masonry sewer originally built 120 years before, with no concrete lining. The use of trenchless methods was considered inappropriate owing to the very high water table, reaching almost to the crown, and the very limited soil cover of only 2 metres. The new concrete pipe of 2.5 m diameter was installed by pipe jacking from access pits, while the spoil was removed through a narrow trench only 1.2-1.5 m wide by an excavation working from the surface. In this way it was possible to break out and remove the old masonry in order to remove any obstructions in the line of the new pipe, along with making provision for dewatering. The method was also capable of dealing with slightly curved sections having radii of 600 m and 450 m. Although a European patent for this method had been issued in 1988, it had not previously been employed along the line of an original sewer. A description of the work involved and of the installation of a siphon pipe as a temporary connection between the 2 exposed ends of the original sewer is presented. (English translation 120 pounds sterling, valid for 1995) **Germany**

95-0830

**Underground replacement of existing, non-man entry sewer pipes along the same route ('crush lining').**

K. ZAPF (Umweltbehörde der Freien und Hansestadt Hamburg)

*Abwassertechnik*, 1994, 45, No 5, 26-27 (in German)

An outline is given of the scope of a development project being co-ordinated by the Hamburg sewerage undertaking in conjunction with machinery suppliers and the School of Construction Engineering

## UNDERGROUND SERVICES

ing at RWTH Aachen, for the development of a new trenchless technique for sewer rehabilitation. The proposed method resembled the process of burst lining, but involved not only breaking up but also removing the fragments of the original sewer during the installation of the new pipe. The project was subdivided into 2 stages: the first involving design and development of the equipment and the second the testing of a prototype under field conditions in Hamburg. A summary of progress achieved to date is given. Very high impact frequencies were necessary to achieve the required degree of disintegration of a concrete pipe, so that only fragments of no greater length than 3 cm were produced. (English translation 60 pounds sterling, valid for 1995) **Germany**

### 95-0831

#### **Reduction of energy losses in inspection chambers for sewers and sewer pipelines.**

P. UNGER and G. ZANKER

*Abwassertechnik* 1994 45, No 5, 48-50 (in German)

The hydraulic performance of inspection chambers is discussed with particular reference to experiments at the instigation of the ATV Technical Committee engaged on the task of revising and updating the relevant ATV Code of Practice (ATV A110). Some of the results obtained for the energy losses occasioned by different chamber configurations, such as the relative position of the inlet and the curvature on the approach to the chamber, are discussed and values for headloss and hydraulic roughness coefficient are plotted as a function of the flow rate. Some detailed recommendations and conclusions arising from the tests are summarized. (English translation 75 pounds sterling, valid for 1995) **Germany**

### 95-0832

#### **Packer for renovation of the junction zone between the principal sewer and service pipes**

R. TELAAK

*Abwassertechnik* 1994 45, No 5, 62 (in German)

The development of a special inflatable packer for isolating the junction of the branch sewer pipe with the principal sewer was entrusted by the Federal Ministry for Research and Development to the firm of Umwelttechnik Franz Janssen GmbH of Kalkar. The design of the prototype unit is described, together with its mode of operation, which was controlled with the aid of a TV inspection camera fitted with wide-angle lenses. By inflating a cushion above the device a cylindrical plug could be inserted into the branch pipe, after which sealant could be applied to the inside of the connecting pipe. On completion of the inspection and setting of the sealant the cushion and the plug could be withdrawn with the aid of a vacuum pump. The equipment was available in 2 sizes for use in principal sewer pipes on the 200-250 mm and 300 to 600 mm diameter ranges. (English translation 45 pounds sterling, valid for 1995) **Germany**

### 95-0833

#### **On-site testing of pipe jacking using a new type of ductile iron pipe.**

F. SCHMAX

*Abwassertechnik* 1994 45, No 5, 65-66 (in German)

A new type of ductile iron pipe with specially designed joint sealing arrangements was developed by the Gildemeister pipelaying firm in collaboration with the Berlin city water undertaking. The ends of the pipe were recessed in such a way that the conventional bell and spigot was replaced by a press-fit system with a flush outer profile. This enabled successive pipe sections to be driven without the need for spacers or other form of stress distributor, as the force was transmit-

ted directly by the pipe walls and no lateral forces were generated. The integrity of the joint was ensured by a built-in Tyton sealing ring. The pipes were supplied in lengths of 2 m with a diameter of 250 mm and jacking could be performed using conventional equipment. A brief description of 2 pipelaying projects in the suburbs of Berlin is given, in which 2 lengths of approximately 350 m of a sewer 4.5 m below ground were installed by this method. Lengths of up to 122 m could be packed into place in one operation and the newly installed pipe was satisfactory when tested under 15 bar pressure and also a partial vacuum of 0.5 bar absolute pressure. (English translation 45 pounds sterling, valid for 1995) **Germany**

### 95-0834

#### **A gradual rehabilitation programme for combined sewerage systems.**

T. KIRYU (Sewage Works Bureau, Yokohama)

*Journal of Institution of Water and Environmental Management* 1994 8, No 5, 480-489

The sewer rehabilitation programme in the flood-prone administrative and economic centre of Yokohama is described. The combined sewers were often shallow, in poor condition and inadequate in capacity. Sewer flow direction, cross-section, depth and flow capacity were surveyed. CCTV inspections were undertaken. Initial plans to separate the sewage were abandoned because of cost, disruption and the polluted surface drainage. The system was evaluated by a storm discharge model which took account of surcharge. The programme was then formulated by trial and error. Improvements were phased so that beneficial results were immediately available. Storm water sewers were converted to combined sewers to make use of capacity and reduce disruption. Where convenient, new sewers were constructed. **Japan**

### 95-0835

#### **Lake County sewer digs deep to solve century-old problem**

B. FISCO (Aquatech Inc., Streetsboro, Ohio)

*Water & Wastewater International* 1994 9, No 5, 46-47

Problems of flow back-up in deep storm water tunnels were rectified using a custom-designed combined clean-up/vacuuming unit. A positive displacement exhaustor provided high vacuum. Discharge was accommodated in a 2500 gallon water tank and 15 cubic yard solids collector which allowed prolonged off-road operation. Application of the system to the Lake County sewer system is briefly described. **U.S.A.**

### 95-0836

#### **The sewage flow diverter**

A. DÖRR (Stadtbauamt, Karlsruhe)

*Korrespondenz Abwasser* 1994 41, No 10, 1730-1733 (in German, English summary)

Serious difficulties could arise in connection with storm sewer operation during periods of low rainfall as a result of unauthorized connections or accidental spillages which gave rise to a high concentration of pollutants in the discharge. To counteract this problem a simple flow diversion structure is proposed which incorporated a floating baffle controlling a sluice which enabled low flows to be diverted into a separate pipe connected to the foul sewer. In this way the contaminated runoff which would normally be retained in the storm sewer, including the first flush which occurred in the early stages of rainfall events, could be released into the foul sewer network and subsequently provided with the necessary treatment. The by-pass connection to the foul sewer must be fitted with a non-return valve in the shape of a hinged flap to prevent foul sewage

from backing up into the storm sewer network. Details of the construction of this simple device which was obtainable from the firm of Steinhard Wassertechnik in Taunusstein are presented. (English translation 155 pounds sterling valid for 1995). Germany

95-0837

**Ecological urban drainage as a recent visible quality feature for urban spaces.**

H. DREISEITL (Atelier Dreiseitl, Überlingen)

*Wasserwirtschaft* 1994/84, No 9: 452-455 (in German, English summary)

Until recently, stormwater had usually been channelled underground in towns and cities and conveyed as rapidly as possible to a remote outlet, with the result that it was forced out of sight and out of mind for the general public. This trend was being reversed in many places with the implementation of new schemes for urban drainage where open channels were once again employed, although confined strictly to unpolluted surface runoff. By allowing the runoff to traverse a series of landscaped channels, frequently augmented by natural stone cascades, the surrounding townscape could be made more pleasant and aesthetically attractive, while in the outer residential districts the channel could become part of a play area through which the flow could be directed prior to collection of the runoff in retention ponds or infiltration basins. Some recent examples of such schemes are discussed where planting and installation of fountains had contributed to the visual appeal. (English translation 185 pounds sterling valid for 1995). Germany

95-0838

**Ecologically-based approaches to stormwater management in the Emscher region.**

M. BECKER (Emschergerossenschaft, Dortmund) and H. FUCHS

*Wasserwirtschaft* 1994/84, No 9: 456-460 (in German, English summary)

The ecological regeneration of the Emscher catchment drainage network is discussed, and the various criteria essential to a successful transformation from an artificial to a varied natural environment are discussed. As a first consideration the rate of runoff must be retarded and if the renaturalized channels were to remain water-filled during dry weather periods, some form of upstream retention capability would be required, coupled with a method of controlled release. In some situations the extent of the paved surfaces could be reduced and alternative methods of drainage and infiltration might be adopted which reduced the volume of runoff to be transported above ground or in sewer pipes. A range of such techniques is considered and their relevance to the collection and disposal of runoff from various sources is evaluated. Several novel types of infiltration system for surface runoff are described, and their potential for enhancing the urban landscape assessed. (English translation 185 pounds sterling valid for 1995). Germany

95-0839

**The example of Deininghaus brook.**

A. STECKER (Emschergerossenschaft Lippesverband, Essen)

*Wasserwirtschaft* 1994/84, No 9: 462-466 (in German, English summary)

In the context of the Emscher drainage network renovation scheme the Deininghaus brook in the Castrop-Rauxel district was subjected to a process of renaturalization. With this in view, new drains for the collection of foul sewage were laid and separate storm drains provided while all the previous combined sewer overflows were taken

out of service. In addition stormwater retention tanks were installed to raise the quality of the runoff eventually discharged to stream. These measures were being accompanied by a programme of regrading and replanting of the channel and the banks on either side, to restore the native habitat. These works which affected a 9.5 km length of the stream, were programmed in several stages, making up a 10-year overall programme which is outlined with the aid of a progress chart. (English translation 220 pounds sterling valid for 1995). Germany

95-0840

**Innovative Lavernock sea outfall construction to protect historic environment and preserve South Wales' beaches.**

CHRISTIANI & NIELSEN LTD

*Water & Wastewater International* 1994/9, No 5: 18-20

Initial stages in the construction of the 4.8 million pounds sterling Lavernock sea outfall project are outlined. Sewage from 5 areas would be treated at Cog Moor and disposed to sea via a 1250 m outfall pipe. Pipe strings of 100 m length would be fabricated above the sea cliff and winched to the launchway ramp through a 5 m high tunnel constructed to preserve a site of special scientific interest. The pipe would be laid in a pre-dredged sea trench by a novel land-based technique using pushing jacks. U.K.

95-0841

**North West tows the line**

*Water Services* 1994/98, No 1184: 18-19

Two massive concrete-coated steel outfall pipelines had been towed out to sea in Cumbria as part of North West Water's 500 million pounds sterling Sea Change environmental improvement programme aimed at cleaning up the north west coast. The Sea Change pipelines comprised a stormwater outfall and a long outfall to discharge treated wastewater, and were part of a series of 5 pipelines. Four of the pipelines were being constructed by the bottom pull method with the pipes assembled into a string closed to the line of the outfall. The fifth outfall, a 250 m long, 1.6 m diameter storm outfall, had been floated 25 km along the coast before being flooded and allowed to slip into a trench blasted through seabed rock. A new treatment works was also being constructed near Siddick to treat local wastewater. U.K.

95-0842

**Automatic filters to remove clams and algae from irrigation water**

*Filtration & Separation* 1994/31, No 7: 697 and 699

A range of options were considered for removing debris from irrigation water used in the city parts at Scottsdale, Ariz., and these included physical, chemical and biological approaches. The final solution adopted was filtration with Amiad automatic self-cleaning filters which have a capability for filtering particles as small as 25 µm. The system also incorporated a coarse strainer to remove particles of 0.25 in and larger from the water before it entered the filter. A feature of this system is that when the filter cake grows sufficiently large to create a pressure drop across the screen, the filters flush in the opposite direction in order to remove the accumulated debris. The system was installed in April 1993 and had proved very effective as a barrier to clam larvae. U.S.A.



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95-0843

### **Incorporating economic analysis in irrigation design and management.**

U CHAKRAVORTY (Hawaii University Honolulu) and J ROUMASSET

*Journal of Water Resources Planning and Management* 1994, 120, No 6 819-835

An operational framework is presented for integrating economic concepts into irrigation design and management. Using a simple spatial optimization model, conditions are derived for optimal water allocation at each location in the system. Principles for optimal investment in distribution canals and water conservation technology are described. Irrigated area, conveyance efficiency and aggregate water use at an irrigation farm were determined. The potential economic benefits of the model were demonstrated through its application to data from irrigation projects in the western U.S.A.

95-0844

### **Leaching and water flow patterns in every-furrow and alternate-furrow irrigation.**

J G BENJAMIN (USDA ARS Department of Agriculture Fort Collins Colo), H R HAVIS, I R AHUJA and C V ALONSO  
*Soil Science Society of America Journal* 1994, 58, No 5 1511-1517

Environmental problems involving deep water percolation and chemical leaching arising from furrow irrigation practices are considered. The possibility that alternate furrow irrigation might increase efficiency of water use and decrease chemical leaching as compared with every furrow irrigation was investigated using the SWMS 2D finite element model. Furrow placed and ridge placed fertilizer bands in a clay loam and a loamy sand were modelled in connection with the 2 irrigation methods. The soil water contents after infiltration and redistribution were more uniform with every furrow than with alternate furrow irrigation, though chemical movement was greater. Ridge placement would reduce fertilizer leaching. U.S.A.

95-0845

### **Rehabilitation assessment of the Helmand-Arghandab valley irrigation scheme in Afghanistan**

J WOLF (Development Alternatives Inc, Bethesda Md U.S.A), R ENGLISH and B HAACK  
*Water International* 1994, 19, No 3 121-128

The Helmand-Arghandab valley irrigation system in southern Afghanistan was a major capital resource, producing a large proportion of the country's food grains and cotton. The effects of the civil and military conflict in the region on the land use and environmental changes of this system were investigated using remotely sensed data (Landsat satellite imagery), geographical information systems, global positioning systems and field surveys. The obtained data were used to identify parts of the system that required immediate rehabilitation for the restoration of agricultural productivity. Afghanistan

95-0846

### **Irrigation water cost in Egypt.**

M N ALLAM (Ministry of Water Resources, Muscat, Oman), I M EL ASSIOUFI and P RILEY  
*Water International* 1994, 19, No 3 145-151

Problems in identifying annual operation, maintenance and replacement (OM&R) expenditures needed to maintain the performance of the water delivery system in Egypt are examined. The delivery

system included the High Aswan dam together with large irrigation structures, pumping stations and thousands of canals and drains throughout the Nile river basin. Procedures are given for estimating these OM&R costs and for assessing system benefits in the various use sectors. The development and application of a cost allocation model to the Nile river system is described. Egypt

95-0847

### **Impacts of agricultural drainage well closure on crop production: a watershed case study.**

B P MOHANTY (U.S. Department of Agriculture, Riverside), U S TIM, C E ANDERSON and T WOESTMAN  
*Water Resources Bulletin* 1994, 30, No 4 687-703

Extensive areas of north west central Iowa were flat with shallow depressions and poor soil drainage. The land was drained for agricultural production by land drains and collector ditches discharging to the underlying limestone aquifer through dug or drilled wells. The aquifer was a major regional water resource and scenarios for its protection from contamination by agricultural chemicals ranged from complete closure of the drainage wells to continued use of the wells with effective chemical management. The long-term effect of well closure on agricultural production was modelled for a 471 ha catchment in Humboldt county using a MODFLOW groundwater model coupled with a geographic information system and an empirical crop yield loss model. Low lying and poorly drained areas would flood making them unsuitable for crop production. The non ponding areas became less productive because of the isolation of fields by wetland areas, with an annual average loss of crops of about 18 per cent. There are 31 references. U.S.A.

95-0848

### **Human health aspects of the metals zinc and copper in tissue of the African sharptooth catfish, *C. larias gariepinus*, kept in treated sewage effluent and in the Krugersdrift dam.**

D J van den HEEVER (Technikon OES, Bloemfontein) and B J TREY  
*Water SA* 1994, 20, No 3 205-212

The African sharptooth catfish (*C. larias gariepinus*) was the experimental species used in a study to determine the suitability of treated sewage effluent for fish culture. The pollution status of a natural water source (the Krugersdrift dam) and treated sewage effluent were compared. Fish were placed at the inlet to the dam and in the first maturation pond of the Bloemfontein sewage works. Zinc and copper were analysed in the treated effluent, sediment and fish tissue. Average annual concentrations were similar for treated sewage effluent and for natural dam water, and were much lower than those of the Vaal dam. Copper concentrations were also similar for both locations, but zinc concentrations for dam sediment samples were more than double those of the treated sewage effluent. Concentrations in muscle tissue of fish kept in treated effluent were lower than those kept in the dam. Metal concentrations were higher in livers and kidneys than in muscle tissue. Human consumption of these organs were not recommended. No seasonal patterns would be established. There are 64 references. South Africa

95-0849

### **Peak practice.**

D BURNELL  
*Water Bulletin* 1994, No 626 8-9

The role and activities of Yorkshire Water in conservation and recreation in the uplands of central England are described. Yorkshire Water had commissioned a series of information boards giving

details of walks around their reservoirs and information about the wildlife and habitats that the area supported. The work involved in balancing the demands for conservation and recreation is considered. Recent projects between Yorkshire Water and the Countryside Commission, Forestry Commission and English Nature are outlined. **U.K.**

95-0850

**Conjunctive operation of hydroelectric and thermal power plants.**

R. HARBOE (Asian Institute of Technology, Bangkok, Thailand), J. R. GAUTAM, and P. R. ONTA

*Journal of Water Resources Planning and Management*, 1994, 120, No. 6, 778-793

An integrated approach which combined deterministic dynamic programming and simulation models was developed and used to evaluate long term operation of the Kulekhani reservoir. This reservoir was part of the hydrothermal power system in Nepal. Model objectives were to maximize annual energy generation while treating its outputs of the run-of-the-river and thermal power facilities as variables. Model formulation is discussed. Stochastic behaviour of the system was considered implicitly by introducing synthetic flows. For the Kulekhani reservoir, combined operation improved the output by 26 per cent. **Nepal**

## SEWAGE

See also Abstracts 95-0525, 95-0631, 95-0658, 95-0660, 95-0662, 95-0693, 95-0723, 95-0770, 95-0789, 95-0813, 95-0816, 95-0841, 95-0902

95-0908, 95-0851

**The best of both worlds.**

R. R. WRIGHT (Missimer International, Fort Meyers, Fla.)

*Water Environment & Technology*, 1994, 6, No. 11, 40-44

A wastewater treatment works at Cape Coral, Fla., is described. Treatment comprises secondary treatment and filtration providing effluent water during summer months. Additional treatment facilities including nitrogen and phosphorus removal permit discharge of the effluent to the river in winter when irrigation demand is low. **U.S.A.**

95-0852

**Wastewater treatment goes uptown.**

N. S. HILIC (Department of Environment Protection, New York City)

*Water Environment & Technology*, 1994, 6, No. 11, 46-49

Construction and operation of a new wastewater treatment works on a concrete platform on the Hudson river at New York City are reported. The platform took 6 years to construct and rests on 2305 pilions resting on bedrock under the river. Treatments comprise screening, settlement, aeration, thickening and disinfection with sodium hypochlorite. Aesthetic considerations were reflected in the design and materials of construction. Improvements in environmental quality in the Hudson bay are reported. **U.S.A.**

95-0853

**Emission of laughing gas (N<sub>2</sub>O) in denitrifying activated sludge plants.**

R. von SCHLITHESS (EAWAG, Dübendorf) and W. GUJER (*Gas Wasser Abwasser*, 1994, 74, No. 9, 731-739 (in German, English summary))

The reactions occurring in the course of nitrification and denitrification processes in an activated sludge plant are discussed and the factors conducive to the formation of nitrous oxide outlined. Due to its absorption in the infra red region it ranks alongside carbon dioxide and methane as a potentially important greenhouse gas, while its reactivity with ozone to form nitric oxide could have an adverse effect on the ozone layer. As a basis for quantifying these effects a mathematical model of the formation and destruction of nitrous oxide in the sewage plant environment was developed and tested against experimental data for nitrous oxide emissions in a bench scale activated sludge system and also from a full scale sewage treatment plant at Opfikon. While nitrous oxide could accumulate in certain parts of the activated sludge system where the dissolved oxygen content is lowest, it was dependent on gaseous exchange processes at the air-water interface for its release to the atmosphere. The rate of transfer however was only significant where fine bubble aeration exerted a stripping effect by bringing dissolved gases to the surface. The quantities released to atmosphere were insignificant in relation to the possible emissions from other sources. (English translation 250 pounds sterling, valid for 1995)

**Switzerland**

95-0854

**Evaluation of chemicals to control the generation of malodorous hydrogen sulphide in wastewater.**

N. TOMAR (Ministry of Public Works, Salmiya) and I. H. A. ABDULLAH

*Water Research*, 1994, 28, No. 12, 2545-2552

The ability of various chemicals to suppress hydrogen sulphide emissions from sewage was investigated initially in the laboratory with sewage of pH 7.2-7.8 containing 18-25 mg sulphide dissolved per litre at 35°C. The oxidation of 1 g sulphide required 1.25-2.0 and 1.8 g hydrogen peroxide, sodium hypochlorite and calcium hypochlorite respectively. The removal of 1 g of sulphide with iron needed 8 and 4 g of iron(II) and iron(III) respectively. A combination of sodium hydroxide and sodium hypochlorite reduced the hypochlorite demand by 50 per cent and was cost effective in the warm climate of Kuwait. A field trial in which a shock load of sodium hydroxide was followed by sodium hypochlorite reduced dissolved sulphide by 57 per cent and gaseous hydrogen sulphide by 70 per cent. **Kuwait**

95-0855

**Hamburg sewage treatment plants - operating experience.**

F. SICKERT

*Abwassertechnik*, 1994, 45, No. 5, 32-44 (in German)

A review of the performance and practical experience of sewage treatment operations at the 2 major Hamburg sewage treatment plants is given. The general layout of each station (Kohlbrandholt/Dradenau and Südlinger Moor) is described together with their annual pollutant discharges, capacities and effluent quality parameters achieved during 1993, and comparison with previous years. Some special topics are singled out including day-to-day fluctuations in sewage composition, with peak values of nitrate at certain times, the concentrations and amounts of heavy metals in the sewage sludge and sewer slime, the use of moss (*Sphagnum recurvum*) as a biomon-

dicator for heavy metals in the sewer network and the exceptionally high proportion of dioxins present in domestic sewage from the Hamburg area which had been attributed to the bleaching of dyes from garments during the washing process. Trials of biological phosphorus removal at the Kohlbrandhof-South works in 1992 proved unsuccessful and were discontinued. The treatment of sludge liquors by the Hypox process was commenced based on the use of a fluidized bed for biological nitrification using pure oxygen followed by conventional denitrification with methanol as an external carbon source. A pilot plant with a throughput of 1.5 m<sup>3</sup> per h is currently in use. Other aspects considered include the optimization of energy costs, occurrence of corrosion in final settling tanks and the use of heat pumps for recovery of heat disposal and utilization of sewage sludge and the reuse of treated sewage effluent. (English translation 465 pounds sterling, valid for 1995) **Germany**

#### 95-0856

##### **Continuous monitoring of organic loadings in sewage treatment plants: use for process control and as an aid to plant operation**

P. H. GAUDRIOT (Cabinet Guadriot), M. Y. LAROYE, M. MAZET and M. BAUDU

*Fau Industrie Nuisances* 1994, No 176, 83-88 (in French, English summary)

A 3 year programme of research in collaboration with Limoges University was concerned with the statistical interpretation of data supplied by groups of sensors for the measurement of parameters in a sewage treatment plant. The programme demonstrated the feasibility of monitoring the behaviour of a sewage treatment system in response to fluctuating loads by continuous sensors for certain simple parameters (e.g. suspended solids, volatile suspended solids and COD in the influent, the organic matter (MSS) content of the aeration tank and the suspended solids content of the plant effluent). In addition, the continuous monitoring of sludge settling behaviour permitted the development of sludge bulking to be detected and sensors for the activity of the biomass indicated the possible occurrence of toxic effects. These measurements enabled a mathematical model of the operation of the system to be constructed and used as a basis of the computerized control of the plant. The application of this model, coupled with an expert system reflecting the response of the plant to certain specific perturbations, was tested on the sewage works for Limoges (180 000 PE) using Windows software and a PC 486 DX 2 66 computer with mimic diagrams. These trials were in progress; a brief description of the benefits and capabilities of the system is given. (English translation 165 pounds sterling, valid for 1995) **France**

#### 95-0857

##### **Central monitoring and central functions - greater security, lower cost.**

E. GELRING (IB Grombach & Co AG, Zurich)

*Gewässer Abwasser* 1994, 74, No 9, 754-760 (in German, English summary)

The benefits achievable from the introduction of centralized monitoring and process control facilities at plants for sewage treatment and other utility installations are discussed. The use of telemetry and remote sensing techniques for collecting data and determining the operating behaviour at outlying pumping stations enabled system operations to be co-ordinated from a central control point which could be conveniently sited close to a principal treatment plant, so that process control functions at this site could also be routinely monitored. The use of such a centralized system enabled breakdowns

or other operating disturbances to be detected more rapidly and also allows a much more efficient use of resources, both of equipment and manpower. There had been a decrease in the price of such control equipment during recent years and its use had become more widespread. A typical design concept for a centralized control system is presented, and some data are presented in graphical form showing how energy costs could be reduced by taking advantage of off-peak tariffs for electricity, when operations could be controlled from the centre. (English translation 205 pounds sterling, valid for 1995) **Switzerland**

#### 95-0858

##### **Fate and effects of cyanide during wastewater treatment processes.**

S. R. WILD (Consultants in Environmental Sciences Ltd., Birmingham), I. RUDD, and A. NEELER

*Science of the Total Environment*, 1994, 156, No 2, 93-107

The literature on the behaviour of cyanide and its species in conventional sewage treatment works is reviewed. Its chemistry, speciation associated toxicities and sources are first considered. Cyanide species were removed by stripping, adsorption onto particulate matter, chemical transformation and biodegradation, with little removal occurring during primary sedimentation. The possible adverse effects on sewage treatment are noted, the most sensitive processes being nitrification and denitrification. Complexed cyanide was less toxic than free cyanide. Acclimatization of bacteria to all cyanide species occurred. Data on removal efficiency and cyanide levels in typical industrial effluents and wastewaters are tabulated. There are 74 references. **U.K.**

#### 95-0859

##### **Monterrey begins 193 M U.S. dollars project to treat wastewater completely.**

G. HALLINAN (Black & Veatch, U.S.A.)

*Water & Wastewater International* 1994, 9, No 5, 27-28

The proposed construction of 3 wastewater treatment works incorporating secondary treatment and disinfection, improvements to the existing sewer system, extension of sea outfalls and a pumping station to improve water quality in the natural waterways of Monterrey are briefly presented. Untreated wastewater currently enters watercourses used for agricultural irrigation. Work commenced in 1992 and completion was planned for 1995. **Mexico**

#### 95-0860

##### **Heavy metals contribution of household washing products to municipal wastewater.**

D. JENKINS (California University Berkeley) and L. L. RUSSELL

*Water Environment Research* 1994, 66, No 6, 805-813

A study that involved the sampling and analysis for heavy metals of influent and effluent wastewaters, domestic water supplies, industrial, commercial and residential discharges and household washing products was conducted in the Southern San Francisco bay area, Calif., U.S.A. The study was conducted as part of a discharge permit assistance programme for the cities of Palo Alto, Sunnyvale and San Jose/Santa Clara. The heavy metals were arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver and zinc. The household washing products included laundry and dishwashing detergents, bleaches and fabric softeners. In no case were household washing products the major heavy metal contributor to influent wastewater or wastewater effluents. Arsenic (13 per cent) was the only contribution above 0.5 per cent. Household washing products contributed

5 per cent of the arsenic load to the current discharge permit level and 3 per cent to the proposed discharge permit levels. When expressed in terms of their contributions to the net residential waste water only, household washing products contributed 73 per cent of the arsenic, 6.5 per cent of the cadmium, 5.6 per cent of the chromium, and 3.2 per cent of the nickel. For mercury, silver, lead, copper, and zinc, household washing products contributed 0.5 per cent or less of the net residential wastewater component. U.S.A.

#### 95-0861

**Identification and characterization of bacterial activities involved in wastewater treatment by aerobic fixed-bed reactor** S. ZINEBI (Faculté des Sciences), C. HENRIETTE, F. PETITDEMANGE, and J. C. JORET

*Water Research*, 1994, 28, No 12, 2575-2582

Four Bicarbonate reactors in series were fed with settled domestic sewage by gravity. Process air entered approximately one quarter of the distance from the bottom of the expanded schist packing. The final column was not aerated. No backwashing was undertaken during the 3 d period of bacterial colonization. Media were sampled weekly and bacterial populations examined. There was a decreasing gradient of biomass from top to bottom of the reactor with backwashing removing superficial layers of biofilm, about 48 per cent of the fixed biomass. Approximately 100 bacteria were identified and classified in different metabolic groups. Lipolytic, glucidolytic, and proteolytic activities were exhibited by 72, 12 and 8 per cent of the isolates, some showing more than one property. No ozonation was observed. Most species belonged to *Acinetobacter*, *Enterobacteriaceae*, *Aeromonas*, *Flavobacterium* and *Pseudomonas*. There are 43 references. France

#### 95-0862

**Elimination of foreign matter in membrane-type biofilm reactors with reference to the decomposition of 2,4,5-trichlorophenol**

A. WOBUS (Technische Universität Dresden), J. SCHNEIDER, and I. ROSKE

*Korrespondenz-Abwasser*, 1994, 41, No 10, 1828-1830 and 1832-1834, in German, (English summary)

Experiments with 2,4,5-trichlorophenol as the test substance were used to compare the effectiveness of 3 different types of reactor for the removal of persistent contaminants from biologically treated waste waters. Two of the reactors used identical polyacrylic cylindrical casings; in one a close-fitting polyethylene insert ensured a laminar plug flow hydraulic regime of a total length of 15 m. In the other several coils of silicone membrane tubing, covered in a woven wire sheath, were inserted. The silicone tubing was sufficiently permeable to enable oxygen to diffuse through the wall of the tube to support the growth of the biofilm on the outside, where the coils were held apart by the wire mesh. The rates of decomposition of the organic substrate in these 2 continuous flow reactors were compared with that in a sequencing batch reactor system (SBR) in the laboratory. The discontinuous mode of operation associated with the SBR system produced a more uniform colonization of the surface of the tubular membrane, but the continuous flow reactor system exhibited a very slightly increased decomposition, together with a reduced sensitivity to shock loading. Sorption of the substrate onto the biomass was a contributing factor in the overall elimination performance. (English translation 180 pounds sterling, valid for 1995). Germany

#### 95-0863

**Use of powdered clay to upgrade activated sludge process**

P. CHUDOBA (Degremont Research Centre, Le Pecq), and M. PANNIER

*Environmental Technology*, 1994, 15, No 9, 863-870

The addition of powdered clay into a conventional activated sludge process was investigated as a means of upgrading treatment plants. The performances of 2 experimental pilot plants were monitored: (1) an upgraded activated sludge system with powdered clay addition and (2) a conventional activated sludge plant. Addition of powdered clay decreased the applied sludge loading, increased the solids flow loading and enhanced the nitrification capacity. Plant volume could be reduced by 30 per cent compared with a conventional activated sludge process. The powdered clay improved the thickening capacity and dry solids content of the excess sludge. The powdered clay was a waste product from the production of kaolin and additional costs were therefore low. France

#### 95-0864

**Activated sludge kinetics in relation to filaments and foam formation**

R. J. FOOT (Wessex Water plc, Poole) and C. I. FORSTER

*Environmental Technology*, 1994, 15, No 9, 879-885

Kinetic coefficients differed according to the relative numbers of filamentous and non filamentous micro organisms. A study was conducted in Dorset to examine the way in which the kinetic constants of activated sludges were related to the dominance by *Microthrix parvifella*, the principal foam-forming species. Respiriometric measurements were made using synthetic sewage. Changes in the kinetic coefficients of foaming activated sludge cultures coincided with changes in the filamentous component of the floc. Higher specific growth rates and kinetic ratios occurred when the *M. parvifella* population increased. Kinetic values decreased with decreasing temperature. The relationships between temperature and microbial activity could suggest that the practice of controlling foam by reducing mixed liquor suspended solids concentrations might place treatment performance (nitrification) at a greater risk than previously thought, particularly when the foam was dominated by *M. parvifella* and foam production occurred in the winter period. U.K.

#### 95-0865

**The combined effect of influent quality and anoxic selector on activated sludge settleability**

M. P. de POORTER (Gent University), E. FORSTH, H. BOGAERT, and W. VERSTRAET

*Environmental Technology*, 1994, 15, No 10, 957-967

This experimental work was carried out on a laboratory scale activated sludge system using a synthetic wastewater in 3 forms (fresh influent, acidified influent and septic influent) to determine the effects on sludge settleability and metabolic capacity both with and without an anoxic selector. Using an anoxic selector with an hydraulic detention period of 8 minutes, COD removal efficiencies were high and ranged from 72 to 85 per cent of the influent soluble COD value. The molecular size of the soluble influent COD had no apparent influence on the selector efficiency. Growth of filamentous bacteria was stimulated in the presence of low molecular weight compounds but only when no selector phase was provided, i.e. when no selector was provided. This suggests that the selector had a stabilizing influence on the influent quality. Belgium

95-0866

**Vitamin supplementation in biological effluent treatment: part I: requirements of the heterotrophic saprophytic flora of communal and industrial activated sludges for vitamins of the B-complex and their effects on enzyme activities and decomposition behaviour.**

G. LIND (Landesanstalt für Wasserversorgung, München), M. SCHADE, G. METZNER and H. LEMMER  
*GWf Wasser/Abwasser*, 1994, 135, No 10, 595-600 (in German, English summary)

The density of saprophytic bacteria, the activity of various enzymes and the degradation of selected persistent substances by activated sludge biocones of municipal or industrial origin were investigated. The effects of supplementation with B group vitamins were examined either in association with each other or by eliminating one vitamin at a time. The vitamins tested in this way were thiamine, riboflavin, folic acid, biotin and nicotinic acid. Only very slight improvements in the level of activity of the biocones were apparent from which it was inferred that a sufficient number of vitamin-producing organisms was present to satisfy the demands of the consumers. Isolates for which a supply of B vitamins was essential could be obtained from all the biocones tested, but only biotin, thiamine and nicotinic acid were essential growth factors, and no isolates with an essential requirement for riboflavin, folic acid or pyridoxine were obtained. (English translation 195 pounds sterling valid for 1995). **Germany**

95-0867

**Inhibition of the nitrification process in municipal wastewater treatment plants by industrial discharges**

H. GRUTNER (Water Quality Institute, Hoersholm), M. WINTHER, NIELSEN, L. JORGENSEN, P. BOGEBJERG and O. SINKJAE

*Water Science & Technology*, 1994, 29, No 9, 69-77

Industrial discharges interfering with nitrification in the sewage works of Copenhagen were identified by direct testing of inhibitory effects. Sewages were sampled on entering the works from selected parts of the sewerage network and from individual industries. They were tested for nitrification inhibition by the ISO9509 procedure and a screening test devised by Arvin. Investigations were made at normal times and during the industrial holiday. During the latter period, inhibition fell and the treatment plant achieved its full nitrification capacity. Individual industrial effluents were quantified by the number of times dilution was necessary to give a 20 per cent inhibitory effect on nitrification. A control strategy was formulated for load control, control according to general guidelines and the setting of individual requirements. **Denmark**

95-0868

**Influence of activated sludge flocculation time on secondary clarification.**

E. J. WAHLBERG (Clemson University), T. M. KEINATH and D. S. PARKER

*Water Environment Research*, 1994, 66, No 6, 779-786

The success of gravity separation of activated sludge from a treated effluent depended on the flocculent nature of the mixed liquor entering the secondary clarifier. A theoretically based, easily performed batch flocculation testing procedure was developed which defined activated sludge flocculation characteristics. The test was based on measurements of supernatant turbidity after 30 minutes of settling as a measure of the primary particle number. The procedure was applied to 30 activated sludge samples obtained from 21 full-

scale facilities. Estimates of the alpha parameter indicated that the degree to which residual supernatant turbidity could be lowered was comparable for a wide variety of activated sludges. The results indicated that flocculation of activated sludge could not be used to reduce supernatant suspended solids below a certain limit. Estimates of the lambda flocculation parameter confirmed that the removal of supernatant turbidity was rapid (99 per cent complete within 10 minutes in 24 activated sludge samples). The magnitude of the flow aggregation and breakup rate coefficients appeared to be specific to the flocculation system used for their estimation. **U.S.A.**

95-0869

**Phosphate removal by simultaneous coagulation in a pilot plant: trials of a new flocculating agent.**

B. TABRI (IUT de Colmar), B. CLAMENS, J. P. SAUGIER and O. DIEZSCH

*Eau Industrie Nuisances*, 1994, No 176, 75-77 (in French, English summary)

Experience of phosphorus removal from municipal sewage by simultaneous coagulation using aluminium sulphate and ferric chloride had shown that the prescribed residual level of total phosphorus of 1 mg per litre or 2 mg per litre (depending on the size of the plant) was frequently exceeded and attempts to increase the extent of phosphorus removal efficiency tests were carried out on small pilot plant using a new aluminium based coagulant, designated VTA 24-5, produced by the firm of VTA Austria GmbH. The results of experiments using amounts of 0.023 or 0.046 ml per litre of the proprietary liquid added to the clarifier (5 litres capacity) are presented, showing that the limiting value of 1 mg per litre of total phosphorus was complied with at the higher dose. The effects of the compound on the removal of organic matter and nitrogen were also beneficial and the settleability of the sludge was markedly improved. The compound was also tested on the Trois Fontaines sewage treatment plant and while the initial costs were on 50 per cent greater than for the conventional coagulant, after several months the consumption of VTA 24-5 fell by 30-50 per cent, with the result that it became competitive with the standard method of treatment. (English translation 85 pounds sterling valid for 1995). **France**

95-0870

**'MAPping' out future treatment of wastewater in the EU.**

B. DUMBLTON

*Water & Waste Water International*, 1994, 9, No 5, 60-61

Present research and pilot plant work reported by Watergroup A/S (Denmark) is summarized. Restrictions on the quality of effluent from wastewater treatment works are considered briefly. Ways of treating water from sludge dewatering systems are identified including biological, physico-chemical and the magnesium ammonium phosphate (MAP) process. Treatment processes are briefly described. In the MAP process, solids from wastewater are flocculated and removed by sedimentation. Reject water is first dosed with phosphoric acid and carbon dioxide removed by air diffusers. Magnesium oxide is then added at the nitrification stage which removes approximately 70 per cent of the ammonium. In the final stage pH is adjusted with sodium hydroxide before a lamella separator. **U.K.**

95-0871

**Pore relations.**

A. TURNER

*Water Bulletin*, 1994, No 626, 10-11

Developments in membrane technology to improve cost-effectiveness and optimize membrane performance for wastewater treatment

are discussed. A unique submerged membrane process developed by Kubota had been launched in the U.K. by licensee Davy International. The process used microfiltration to treat raw domestic or industrial wastewater. The membrane was integrated within the aeration basin to form a bioreactor system, with an air diffuser system providing a motive force for airlift circulation. The membranes were also self-cleaning, preventing clogging. A pilot trial was being carried out by Wessex Water for a 480 population equivalent U.K.

95-0872

#### Urban retrofit on a grand scale.

J. P. NEWBY (Department of Environmental Services, San Jose, Calif.) and S. G. HOUGH

*Water Environment & Technology*, 1994, 6, No 11, 34-39

Discharge of effluent from the San Jose-Santa Clara water pollution control works into salt marshes threatened the habitat. Plans for reuse of treated effluent to reduce demand for potable water required a survey of potential customers and results of a market survey are presented. A potential market for 1400 litres per second was identified with a peak demand of 4560 litres per second. Management guidelines for using recycled water for landscape irrigation are presented according to individual chemical and physical parameters. A new distribution system comprising storage reservoirs, booster pumps, and up to 515 km of pipeline will be required. Project costs of approximately 460 million U.S. dollars were estimated. U.S.A.

95-0873

#### Mathematical modelling of particle size distribution in secondary effluent filtration.

G. ALON (Jerusalem Municipality) and A. ADIN

*Water Environment Research*, 1994, 66, No 6, 836-843

Particle size distribution has not been taken into account in deep bed filtration models which tend to concentrate exclusively on process parameters. Direct filtration tests were conducted in which secondary effluent from a municipal activated sludge plant was filtered through perspex columns 0.6 m high and 0.55 mm in diameter containing sand with geometric mean sizes of 0.767 mm, 0.917 mm, and 1.3 mm, respectively. The cumulative removal efficiencies were determined according to particle number and volumes in the fine and coarse media. The power law function expressed the particle size distribution better than linear, logarithmic, or exponential functions. The experimental results demonstrated its validity and application for predicting head loss using function parameters and a Kozeny-based equation. Israel.

95-0874

#### Subterra - plant-based treatment systems with sub-surface input of liquid.

U. ANKARA (ZEWU, Hamburg) and U. LAMMERS

*Korrespondenz Abwasser*, 1994, 41, No 10, 1850-1852 (in German, English summary)

A novel type of plant-based treatment system is described in which the sewage to be treated was introduced into the bed of permeable material from a system of parallel perforated pipes situated below the soil surface. These form part of a recirculating system from which the excess is recycled to the feed tank, while the principle flow escapes through the holes in the pipes and percolates downward through the bed of soil and gravel into the collector system at the bottom. Results of tests with a bed 2 m long, 1 m wide and 80 cm deep are presented. The bed was planted with a variety of aquatic plants and the distributor pipes inserted 20 cm below the surface. The

bed was supplied with settled sewage and the quality of the influent and effluent monitored daily for more than 12 months. The results indicated a high level of elimination of organic matter in terms of both COD and BOD<sub>5</sub>, a high level of nitrification and a substantial level of phosphorus removal, for a loading rate of up to 40 litres per m<sup>2</sup> d. The calculations indicated an overall requirement of 3.75 m<sup>2</sup> per PE. A 95 per cent reduction in bacterial count was also observed and salmonella, which were present in the incoming sewage during 14 d, were completely eliminated. (English translation 100 pounds sterling valid for 1995). Germany.

95-0875

#### Soil amendments for reducing phosphorus concentrations of drainage water from histosols.

E. L. COALE (Maryland University, College Park) P. S.

PORTER and W. DAVIS

*Soil Science Society of America Journal*, 1994, 58, No 5, 1470-1475

The effectiveness of soil amendments in reducing the phosphorus concentration in drainage water from an organic soil in the Everglades Agricultural Area of Florida was investigated. Three soil amendments were added to plastic cylindrical columns containing an organic soil: a water treatment residual containing calcium oxide, aluminium sulphate and a starch-based polymer, commercial agricultural dolomite, and commercial agricultural gypsum. The amended columns were saturated with an aqueous solution containing 5 mg phosphorus per litre and drained. Repeated leaching with distilled water showed that gypsum amendment produced a small increase in phosphorus sorption capacity together with increased soil affinity for phosphorus and lower total dissolved phosphorus in drainage water. U.S.A.

95-0876

#### Disinfection of wastewaters by ultra-violet irradiation

E. FAHEY (Colflux)

*L'au Industrie Nuisances*, 1994, No 176, 58-60 (in French, English summary)

The characteristics of ultraviolet irradiation, and its bactericidal activity (based on its ability to cause changes in the DNA molecule) are discussed, followed by a review of the application of UV disinfection to sewage effluents in France. The design of equipment for this purpose is outlined, while the resistance of various micro-organisms to doses of UV irradiation is considered with reference to the level of intensity required to achieve 90 per cent and 99 per cent reductions in numbers. The intensity of irradiation authorised by the Director of Public Health for disinfection was 25 mJ per cm<sup>2</sup>, but the results achieved were highly dependent on the initial level of contamination and the tendency to fouling of the outside surface of the emitters. The general features of UV disinfection systems for use on treated sewage effluents are reviewed, with a distinction between those where irradiation took place inside closed vessels and those where the liquid flowed through an open channel. The closed system was usually employed for throughputs of less than 80 m<sup>3</sup> per h, and the open channel for larger installations. It was possible to supply an installation capable of treating up to 5000 m<sup>3</sup> per h, corresponding to a treatment plant capacity of 250 000 PE, and the running cost need not be greater than 3.5 cents per m<sup>3</sup>. (English translation 105 pounds sterling valid for 1995). France.

## SEWAGE

95-0877

### **Fun in the sun.**

A TURNER

*Water Bulletin*, 1994, No 625, 8-9

The 12 million pounds sterling Newton Marsh sewage treatment works of Anglian Water incorporated one of the largest UV disinfection facilities in Europe. The works was part of a massive 260 million pounds sterling programme to improve bathing water in the region and meet the December 1995 deadline for EC compliance. Project Clear Water involved the introduction of advanced wastewater treatment technology and the construction of a new sewerage system beneath Cleethorpes. UV light was used to disinfect treated effluent, killing 99 per cent of bacteria, viruses and algae, before it was safely returned to the environment. U.K.

95-0878

### **Comparative studies of solids extraction with the aid of microwave technology.**

G. KNOOP (Bayer AG, Leverkusen), B. PEHL, and D. SCHLOSSER

*Korrespondenz Abwasser*, 1994, 41, No 10, 1836-1839 (in German, English summary)

For the determination of metallic elements in samples of sedimentary deposits and sludges a preliminary digestion with aqua regia in a flask on a hotplate was used to solubilize the elements concerned. In a search for a more efficient and economical method, a variety of alternative reagents was tested in conjunction with heating in a microwave oven. The reagents consisted of different proportions of 2 or more constituents comprising nitric, hydrochloric and hydrofluoric acids and hydrogen peroxide. Several heating phases, including a graded power increase from 250 to 600 watts were included with brief intervals in between. The extracts were analysed for 6 heavy metals (calcium, chromium, copper, nickel, mercury and zinc) and arsenic and the results compared with those obtained by the standard method for reference samples of sewage sludge and river sediment. The results indicated a high level of agreement with, in some cases, higher recoveries using the microwave extraction method. The best reagent was a mixture of 3 parts hydrochloric to 2 parts hydrofluoric acid by volume in all cases. (English translation 100 pounds sterling valid for 1995). Germany

95-0879

### **The fate of *Nocardia* in anaerobic digestion.**

M. HERNANDEZ (California University Berkeley) and D. JENKINS

*Water Environment Research*, 1994, 66, No 6, 828-835

The presence of stable viscous foams on aeration basins and secondary clarifiers has been associated with *Nocardia* growth in activated sludge. The fate and foaming potential of *Nocardia* during mesophilic anaerobic digestion was investigated in batch digestion experiments in continuous flow digesters fed with waste activated sludge with solids retention times of 10, 14 and 28 d. In 2 phase digestion experiments the digestion was divided into acid and methanogenic phases. *Nocardia* filament concentration was measured using an immunofluorescent technique and filament viability was determined by dehydrogenase activity staining. The effects of pH, total solids concentrations and *Nocardia* filament mass on digesting sludge foaming potential were studied. No digestion system completely removed the *Nocardia* filaments. *Nocardia* filaments decayed slowly in single phase mesophilic anaerobic sludge digesters. Decay coefficients were first order and approximately equal to 0.02 per d. There were no differences in the rates of *Nocardia* decay in the

stable digester foam layer and in the digesting liquor. Two-phase digestion enhanced the rates of *Nocardia* filament decay compared with single-phase digestion. U.S.A.

95-0880

### **Dutch deep shaft takes the pressure off wet oxidation.**

P. de BEEKER (VerTech Treatment Systems) and K. HEIJREMA

*Water Quality International*, 1994, No 3, 28-29

A deep shaft sewage sludge treatment process, operating for the Veluwe Water Board in Apeldoorn, The Netherlands, is described. The technique relied on the generation of heat by pressure from the height of a column of sludge (in this case, nearly 4000 ft). Sludge and oxygen were introduced at the top of the inner pipe of a concentric pair of pipes; pressure and temperature increased with depth. At the bottom, a temperature of 275°C was reached. Exothermic oxidation had begun at about 175°C. Dissolved or suspended organic material was oxidized, with most of the organics being converted to carbon dioxide gas, the remainder to biodegradable compounds. The oxidized sludge was returned to the surface via the outer pipe, losing pressure and heat as it rose, but still discharging at 80°C. These 2 pipes were enclosed in a heat exchanger, down which coolant was pumped to maintain an even temperature at the bottom and from which it returned to the surface, via an insulated tube, at 260°C for steam generation and power production. To start the whole process, the heat exchange system was reversed, hot water from an external source being pumped down. The system came on stream in May 1993, following 3 months of pilot scale experiments, and had treatment capacity in excess of that immediately required, assuming other sludge producers would use it. It would eventually handle some 30 000 tonnes of dry sludge per year. Netherlands

95-0881

### **High-efficiency centrifuge produces sludge 10 percent drier than conventional equipment.**

*Water & Wastewater International*, 1994, 9, No 5, 36 and 38

Development of the Centripress by KHD Humboldt Wedag AG (Cologne) is reported. The unique dewatering/pressing technique achieved dewatered sludges 5 to 10 per cent drier than conventional continuously operated dewatering techniques. Application of the system to treatment of wastewater sludge at Petrograd and Prague is reported. Europe

95-0882

### **Centrifuge considerations**

W. S. MCCOY (Malcolm Pirnie Inc., Newport News, Va.), M. A. HAFEY, and A. C. JAIN

*Water Environment & Technology*, 1994, 6, No 10, 52-56

The evaluation, selection and design of 2 high-solids centrifuge installations at wastewater treatment facilities are described and illustrate the factors which need to be considered when selecting a high solids centrifuge. Dewatering performance depended on solids characteristics. Ratio of primary solids to waste activated sludge and solids temperature were critical solids parameters. A higher polymer dose was needed than for conventional centrifuge dewatering. Energy requirement was site specific. Conversion from a conventional dewatering device to a high solids centrifuge increased cake solid content which reduced fuel use and increased furnace throughput capacity. However, effects on furnace operation were not as straightforward when the conversion was more complex, such as from a thermal conditioning system. U.S.A.

95-0883

**Constructive sludge management - reutilization of municipal sewage sludge in Portland cement mortars.**

V. PINARLI (Ondokuz Mayıs University, Samsun) and N. K. EMRE

*Environmental Technology*, 1994, 15, No 9, 833-841

Laboratory studies were conducted to determine the potential for using sludge as a cement replacement material. Digested and dewatered sludge samples from the Kutahya Municipality sewage treatment plant, Turkey, were dried and pulverized and blended with cement for use as a construction material. A cement to sand ratio of 1:3 with a water to cement ratio of 0.5 was used. In each mix 1:40 per cent sludge by weight was used to replace cement. The mortar specimens were tested for compressive and tensile strength after curing periods of 3, 7, 14 and 28 d. Initial and final setting times were longer with an increased sludge content. The addition of 40 per cent sludge caused the initial and final setting times of mortar to increase 19 fold and 35 fold, respectively compared with control mortar with a water cement ratio of 0.5. The effects of sludge on the Le Chatelier expansion and specific surface area of mortar were not significant. Sludge addition adversely affected tensile and compressive strength development. For 5 per cent replacement of cement by pulverized sludge, the compressive and tensile strengths were reduced by 32 and 38 per cent, respectively. Heavy metals from the pulverized sludge were believed to be stabilized and solidified within the cement matrix. **Turkey**

95-0884

**An innovative sludge disposal option - reuse of sludge ash by incorporation in construction materials.**

V. PINARLI (Ondokuz Mayıs University, Samsun) and G. KAYMAI

*Environmental Technology*, 1994, 15, No 9, 843-852

A comprehensive test programme was developed to examine the potential for using pulverized sludge ash from the incineration of digested and dewatered municipal sludge as a cement substitute in mortar. Pulverized sludge ash was blended with cement in the proportions of 5, 10, 15 and 20 per cent by weight. Mortar samples were cured for 3-28 d. Compressive and tensile strengths of mortars with 20 per cent replacement with sludge ash were 94 and 96 per cent of control mortar compressive and tensile strength on the 28th d, respectively. Initial and final setting times were longer with an increase of pulverized sludge ash. The addition of 20 per cent sludge ash caused the initial and final setting time of mortar to increase 2 fold and 2.5 fold, respectively. The pulverized sludge ash had no significant effect on the Le Chatelier expansion and specific surface area of mortar. Heavy metals were believed to be stabilized and solidified within the cement matrix. The organic matter remaining in the sludge ash due to incomplete combustion upon firing possibly retarded the setting of cement and strength development. There are 35 references. **Turkey**

95-0885

**Treating our waste water.**

S. FINCH

*Water Bulletin*, 1994, No 624, 13-14

The managed flow biosdisc from Klugester Environmental Engineering was a new range of off-mains packaged sewage treatment equipment. The system had been designed to combat increasingly high levels of detergent chemicals being discharged into both domestic and commercial off-mains wastewater systems. Hydrocarbon based organic chemicals were absorbed in the biomass in the roughing

stage. Subsequent rotating biological contactor stages could then cope consistently with further biological treatment of the wastewater to provide biological and hydraulic process stability. Three configurations were available to meet different site needs. A recent application of the Biosdisc sewage treatment facility at a nursing home in Gloucestershire is described. **U.K.**

95-0886

**Family latrines and paediatric shigellosis in rural Bangladesh: benefit or risk?**

F. AHMED (International Centre for Diarrhoeal Disease Research, Bangladesh, Dhaka), J. D. CLEMENS, M. R. PAO, and A. K. BANIK

*International Journal of Epidemiology*, 1994, 23, No 4, 856-862

A study of 1529 children under 5 years old who had been exposed to an index case of *Shigella* dysentery was conducted for a month. Rectal swabs were taken from children who had had diarrhoea and any family latrine was inspected and classified. In all 219 children had culture proven shigellosis during the follow-up period. The use of a family latrine appeared to increase the risk of shigellosis. The use of a pit or septic tank latrine did not confer any protection (adjusted odds ratio 0.96) but the use of a hanging latrine in which faeces were deposited onto the ground or into water worsened the odds ratio to 1.42. Installing sanitary latrines might not reduce the incidence of shigellosis but eliminating the use of unsanitary latrines should be a useful intervention. **Bangladesh**

95-0887

**Biosolids management with a utilization core**

E. SLAGLE (Hornsbey Bend Wastewater Treatment Plant, Austin, Tex.)

*BioCycle*, 1994, 35, No 10, 30-33

The Hornsbey Bend wastewater treatment facility is a state-of-the-art biosolids treatment and reuse plant that includes anaerobic digestion, open air drying, land application to an on-site privately operated farm, composting the biosolids with tree trimmings as a bulking agent and marketing the compost. Three wastewater treatment plants treated about 60 m<sup>3</sup> per day to produce biosolids with 18-20 per cent solids which were then land applied (on a 270-acre farm) or composted. Typically, the maximal application rate for land was 10 dry tons per year, limited by the nitrogen uptake ratios of the crops being grown. The compost was in the form of 55 per cent dried biosolids combined with bulking agents such as tree and yard trimmings and was available free of charge to all city departments, civic organizations and non-profit making organizations. One problem was that of drying the biosolids, since the drying beds were very weather dependent and in this context a more permanent and cost effective solution was being sought. **U.S.A.**

95-0888

**Growing trees with biosolids**

J. M. CALLAHAN (Bloomington &amp; Normal Water Reclamation District, Ill.) and G. D. MONTE

*BioCycle*, 1994, 35, No 10, 34-37

Due to the scarcity of landfill space and associated tipping costs, the Bloomington and Normal Water Reclamation District (BNWRD) selected a 238-acre site (with 105 acres devoted to row crop agriculture and 90 acres for a hardwood tree crop for commercial veneer sales) for biosolids application using material from a nearby wastewater treatment plant. An important factor in the development of the hardwood tree crop is the assimilation of nitrogen by the trees and by the bromegrass understory, such that the biosolids were being



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applied in a 3 year phased period so that the tree plantations were able to accept about one third of the 1600 tons of dry solids that the BNWRD generated per year. U.S.A.

95-0889

### Northwest farmers see benefits of biosolids use.

C. TONG (King County Department of Metropolitan Services Seattle, Wash.)

*BioCycle* 1994, 35, No 10, 38-39

Biosolids from King County's Department of Metropolitan Services municipal wastewater treatment plants were being applied to agricultural land as part of the Green Valley Project for recycling such biosolids. Currently, the project covers about 4000 acres of farmland producing hops, fruit, grain, corn and feed crops, and in 1994, 24 000 wet tons will be disposed of in this way. Since the soil nitrogen content varied from field to field, the application rate had to match this variation, and was typically about 4 dry tons per acre. An advantage of using biosolids is that they tend to adjust the pH to a more neutral value and thus improve productivity. Other soil improvements include increased organic matter, decreased wind and water erosion and better soil fertility. U.S.A.

95-0890

### Behaviour and fate of chlorobenzenes in spiked and sewage sludge-amended soil

M. J. WANG (Lancaster University) and K. C. JONES

*Environmental Science & Technology* 1994, 28, No 11, 1843-1852

The roles of volatilization, biodegradation, photolysis and other loss processes on the fate of chlorobenzenes in sludge-amended soil were investigated. The kinetic characteristics of these processes were studied and differences in the behaviour of chlorobenzenes in spiked soil and sludge-amended soil were examined. Volatilization was the principal loss pathway of chlorobenzenes from soil. Biodegradation and abiotic losses were of minor importance. Volatilization of the chlorobenzenes from soils was influenced by compound properties, environmental conditions, soil composition and structure. Chlorobenzenes spiked into soil were lost more rapidly than those applied in sewage sludge (general half-lives of 11-181 and 13-622 d respectively). Loss of individual chlorobenzenes followed 2 step first order processes. During the first stage, volatilization rates were high. The second stage was much slower and was presumably controlled by the rate of compound desorption from soil. There are 35 references. U.K.

95-0891

### Comparison of microbial sulphuric acid production in sewage sludge from added sulphur and thiosulphate

R. D. LYAGI (Universite du Quebec, Sainte Foy), J. F. BEAIS

I. DESCHENES, P. LAFRANCE and J. P. VILLENEUVE

*Journal of Environmental Quality* 1994, 23, No 5, 1065-1070

The use of thiosulphate in comparison to elemental sulphur as a substrate for metal bioleaching was examined. The formation of intermediate compounds (thiosulphate, trithionate, tetrathionate) during the oxidation of elemental sulphur and thiosulphate to sulphuric acid by indigenous sulphur oxidizing micro-organisms (thiobacilli) in secondary aerobically and anaerobically digested sludge was studied. The intermediates were not formed when elemental sulphur was used as a substrate. The acidification risk of agricultural sludge amended with leached sludge was therefore reduced. Trithionate and tetrathionate accumulated in the sludge when thiosulphate was used as the substrate. The metabolism of thiosulphate was slower than that

of elemental sulphur in sludge. The use of elemental sulphur as substrate for metal bioleaching was more attractive than the use of thiosulphate. There are 33 references. Canada

95-0892

### Scottish coastal clean-up project gets go ahead.

L. P. KNIGHTS (Quillpower, London)

*Water & Wastewater International* 1994, 9, No 5, 22 and 24-25

The Levenmouth Purification Scheme to improve the quality of discharge from the catchment and to ensure compliance with the EC Bathing Water and Urban Waste Water Directives is described. Problems associated with water circulation patterns in Largo bay and meeting water quality directives are identified and discussed. Results of marine studies, a land study involving the environmental impact of treatment of waste water, and a study of sewer flows are outlined. A list of preferred options was derived enabling selection of a scheme incorporating a 4.9 km outfall with a 16 port diffuser discharge at 16 m depth. U.K.

95-0893

### Probabilistic approach to initial dilution of ocean outfalls.

H. HUANG (National Oceanic and Atmospheric Administration (NOAA)), J. R. PRONI and J. J. TSAI

*Water Environment Research* 1994, 66, No 6, 787-793

A probabilistic approach for developing initial dilution criteria for ocean outfall discharges and environmental impact assessment of effluent discharges is described. The probabilistic approach based on implementing a probabilistic method with a deterministic initial dilution model is compared with the worst case approach, in which a particular combination of parameters affecting initial dilution was specified and an associated initial dilution was calculated using a deterministic dilution model. In the probabilistic approach a framework was provided for combining data for the parameters which were often available in the form of time series or described in statistics. The result was a description of initial dilution as a function of cumulative or exceedance probability from which the exposure risk level for the marine environment could be estimated. The 2 approaches are compared in a case study of the Miami Central outfall, Fla., U.S.A. U.S.A.

95-0894

### Behaviour of sewage effluent oil and grease in the ocean

T. J. SCHULTZ (New South Wales University, Kensington), P. J.

MARCZAN and A. G. FANI

*Water Environment Research* 1994, 66, No 6, 800-804

Laboratory and field studies were conducted to study the behaviour of sewage oil and grease after discharge to an ocean environment. In studies of synthetic sewage in water, the only variable affecting the amount of coagulation that takes place in synthetic sewage in water was the concentration of detergent, which reduced coagulation. In studies of synthetic sewage in seawater, the volume mean diameter of synthetic sewage in the bulk of seawater increased from 4.5 to 7 µm as the concentration range of synthetic sewage increased from 30.8 to 46 mg per litre. No change in size of particles on the surface was found. Coagulation was unaffected by the soap concentration and by salinity. Some coagulation, with an increase of up to 20 per cent in particle diameter, was predicted to occur downstream of an outfall and downstream of diffusers. A field study was conducted at Burwood Beach, N.S.W., Australia. Grease particles did not increase in size within a relatively short distance of an outfall. The concentration of grease particles on the ocean surface was higher in areas of a visible slick than in non-slick areas. Predicted concentrations of

grease particles were 10-15 times lower than measured values. The removal of oil and grease particles in the upper size range would lower the mass of grease discharged from the Malabar Sewage Treatment Plant. **Australia**

95-0895

## Characterization and treatment of recirculation-stabilized leachate.

F. DIAMADOPOULOS (Technical University of Crete, Chania), *Water Research*, 1994, 28, No 12, 2439-2445

Leachate from recently-deposited solid wastes was treated by recirculation through landfill containing stabilized wastes and then collected in a pond. With COD and BOD of 1141 and 85 mg per litre respectively there was little scope for biological treatment; nitrogen concentration was 250 mg per litre. Coagulation and powdered activated carbon (PAC) could not reduce the COD below 300 mg per litre. Ferric chloride coagulant at pH 4 gave optimal COD removal prior to PAC treatment at pH 7. Air stripping at pH 11.5 could remove up to 95 per cent of ammonia, but this was a slow process. On a large scale, sludge production and the slow rate of ammonia stripping would be problems. **Greece**

95-0896

## Application of immobilized nitrifiers gel to removal of high ammonium nitrogen.

K. TANAKA (Nihon University, Tokyo), M. NAKAO, N. MORI, H. EMORI, T. SUMINO, and Y. NAKAMURA, *Water Science & Technology*, 1994, 29, No 9, 241-250

Nitrifying activated sludge, thickened to 2 per cent by centrifuge, was mixed with polyethylene glycol, 0.5 per cent sodium alginate and potassium sulphite as initiator to form immobilized gel pellets. These were evaluated by placing them in 2 tanks in series fed with exhaust gas scrubber water from a sludge drying plant. They were restrained by wedge wire at the top of the tanks. The pH in the second tank was controlled by sodium hydroxide addition. Some effluent was recycled to the first tank. The lifespan of the pellets in terms of compressive strength was expressed by an Arrhenius type equation. At pH 6.9 and 40°C a lifespan of at least 5 years was projected. Ammoniacal nitrogen of 95-260 mg per litre was removed by 98 per cent in a 6 h retention time. A full scale 480 m<sup>3</sup> per d plant was operating satisfactorily. **Japan**

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See also Abstracts 95-0508, 95-0628, 95-0672, 95-0784, 95-0792, 95-0858, 95-0871

95-0897

## Management of industrial effluent discharges to sewers

S. J. PATEMAN (Glaxo Research and Development Limited), *Waterline*, 1994, September, 51-58

The difficulties involved with effluent discharges from a research and development site in terms of the complexity of the site discharges and their regulation and the different parameters and priorities set by the water service company and Her Majesty's Inspectorate of Pollution (HMIP) are examined. Among the actions necessary to comply with new regulations were containment at source and waste minimization; in many cases both actions were perfectly practical. An example is the identification of alternative supplies of caustic soda manufactured using the diaphragm method and the corresponding

minimization of mercury in the discharge to meet HMIP requirements. Mercury is a contaminant of caustic soda which historically had been manufactured using the mercury cell. **U.K.**

95-0898

## Anaerobic digestion of a mixture of cheese whey, poultry waste and cattle dung: a study of the use of adsorbents to improve digester performance

M. DE SAI (Sardar Patel University, Vallabh Vidyanagar, Gujarat) and D. MADAMWAR

*Environmental Pollution*, 1994, 86, No 3, 337-340

Cheese whey, poultry waste and cattle dung in the ratio 3:2:1 was used as the substrate in bench scale anaerobic digesters. Adsorbents were mixed with the sludge and digester function was monitored. All adsorbents at concentrations up to 4 g per litre increased gas production and methane content. A doubling of gas production was obtained with silica gel (4 g per litre) which also gave a reduction in COD of 78.5 per cent compared with 72 per cent in the control digester. The use of adsorbents might improve the efficiency of digestion and reduce the disposal problem for these waste products. **India**

95-0899

## An examination of different support media in relation to the start-up of anaerobic expanded bed reactors.

K. ALI AOUL (Birmingham University) and C. E. FORSTER, *Environmental Technology*, 1994, 15, No 9, 887-894

Three different support media (sand, pumice, sintered glass) were evaluated for the treatment of synthetic wastewaters (based on ice cream or acetic acid) in anaerobic expanded bed reactors. The hydraulic retention time was 0.3-3 d. Porous media were colonized better than non-porous material. The sintered glass media performed better than the pumice support which had the greater porosity. Components of the ice cream waste inhibited the propionate to acetate conversion. **U.K.**

95-0900

## Reduction of the nitrogen and phosphorus releases from the Dormagen factory of Bayer AG.

R. HANKE (Bayer AG, Dormagen) and H. G. MEYER

*Korrespondenz Abwasser*, 1994, 41, No 10, 1840-1849 (in German, English summary)

Effluent from around 50 chemical production plants and up to 20 petrochemical processes belonging to Bayer AG and situated on a 6 km site at Dormagen have since 1978 been treated in conjunction with sugar refining and brewery effluent in 2 biological treatment plants on the site. One of these, completed in 1973, had a rated capacity of 90 000 m<sup>3</sup> per h and the other, with a capacity of 25 000 m<sup>3</sup> per h in enclosed tanks, was used principally for foul smelling wastewaters. Owing to a decline in the quantities of effluent generated during manufacture, both the flow rates and pollution loads had decreased while effluent quality requirements, particularly for nitrogen and phosphorus compounds had become more stringent. To meet this situation, the smaller treatment plant was reconstructed in 1992 so as to permit preliminary treatment of effluent streams containing larger concentrations of nitrogen and phosphorus, coupled with the provision of 2 stage biological treatment. In its modified form, phosphate coagulation and COD reduction occurred in the initial stage, followed by biological elimination of organic matter and nitrification in the second stage. The nitrate containing effluent from this plant was then diverted to the original large treatment plant where denitrification took place. A description of the modifications and additions to the plant is presented, the final outcome being a reduc-

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tion of 75 per cent in the nitrogen loading and 90 per cent in the phosphate loading of treated effluents entering the Rhine (English translation 275 pounds sterling valid for 1995) Germany

### 95-0901

#### **Industrial waste management in the Athens area.**

D. G. CHRISTOULAS (Athens National Technical University), A. D. ANDREADAKIS, N. KATSIRIS, and A. KOUZELI KATSIRI

*Water Science & Technology*, 1994, 29, No 9, 39-46

Twenty per cent of the 700 Ml of sewage per day discharged through the greater Athens sewerage system is industrial effluent. Principal industries are food, textile, pulp, paper, chemical, tanning, electrical and metal processing. Pre-treatment is usually inadequate and effluents fail to meet standards. Toxic metals at 3-4 g per kg in dry sludge solids are close to the threshold for inhibition of anaerobic digestion. Increased concentrations in the water column and sediments of the receiving water bodies have not been deleterious to benthic organisms. Pilot investigations also indicated no inhibitory effects on sewage treatment processes. Nevertheless a revised and rational regulatory framework was necessary to reduce these metal levels. Data on organic loads, metals and other pollutants in industrial discharges are tabulated. Greece

### 95-0902

#### **Treatment and pretreatment requirements for industrial wastewaters in municipal activated sludge plants.**

W. W. LACKENFELDER (Lackenfelder & Binnie Ltd., Redhill) and J. L. MUSTERMAN

*Water Science & Technology*, 1994, 29, No 9, 79-88

The effects of industrial wastewater on activated sludge plants are discussed. BOD removal kinetics, effects on sludge settleability, the influence of temperature, the volatilization of substances during treatment, the toxicity of effluents, priority pollutants and sludge handling are considered. Readily degradable wastewater could cause filamentous bulking so that plug flow or the use of a selector might be necessary. Refractory wastewater would require an increased sludge age to meet effluent standards. Increasing the soluble fraction of a wastewater made temperature a more important factor, which dictated that higher sludge ages were needed in winter. New restrictions on volatile emissions, limits on sludge toxicity of effluents and the control of specific organic chemicals usually made pre-treatment of industrial effluents obligatory before discharge to sewer. For some individual effluents, sludge handling and disposal would need special attention. UK

### 95-0903

#### **Joint treatment of industrial effluent: a case study of Limassol Industrial estate.**

I. HADIVASSILIS (Hydrotech (Water and Environmental Engineering) Ltd, Limassol), I. TEBAI, and M. NICOLOU

*Water Science & Technology*, 1994, 29, No 9, 99-104

Wastewater at 1000-1200 m<sup>3</sup> per day and 220-264 kg BOD per day from an industrial estate was treated chemically and then biologically. The former processes consisted of pumping and screening, flow balancing, the removal of oil, fat and other matter by flotation, then coagulation/flocculation with lime, ferrous sulphate and polyelectrolyte. After pH adjustment, some nitrogen and phosphorus were added in a selector tank before passage to an aeration tank. Final sedimentation and chlorination. Overall removals of BOD, COD and suspended solids were 91.6, 90.1 and 93.8 per cent, respectively. Detailed results are provided. Cyprus

### 95-0904

#### **Biological removal of nitrogen in toxic industrial effluents, high in ammonia.**

S. BROND (I. Kruger Vest, Aabyhøj), and C. SUND

*Water Science & Technology*, 1994, 29, No 9, 231-240

The treatment of 2 industrial effluents high in ammonia was studied in a full scale BIO-DENITRO process for a rendering effluent and in a pilot scale activated sludge plant for a coke oven wastewater. The latter contained high levels of ammonia and phenol concentrations of 100-800 mg per litre. The rendering effluent contained ammoniacal nitrogen up to 600 mg per litre and COD of 4000 mg per litre. The BIO-DENITRO process, which alternated between aerobic, anoxic and anaerobic states, removed ammonia very efficiently, denitrification was complete for COD to nitrogen ratios above 5. It was important to maintain the pH at 6.5-7.0 to prevent inhibition from ammonia. The coke oven wastewater was balanced to prevent shock loads, pH adjusted, treated with phosphate as nutrient and ferrous sulphate to suppress sulphide and cyanide toxicity. As much ammonia was stripped as possible before treatment by a denitrification/nitrification activated sludge completely mixed process. Treatment was effective with strict pH control, but always prone to malfunction if not closely monitored. Denmark

### 95-0905

#### **Concepts for efficient liquid-solid separation - the key to successful pretreatment of industrial wastewaters.**

J. MIHOPLIOS (Karlsruhe University) and H. H. HAHN

*Water Science & Technology*, 1994, 29, No 9, 347-350

The interactions of specifically coagulated suspensions under defined chemical and physical boundary conditions with various separation reactors of different geometry were investigated. One was short in length but deep, the other long and shallow. The tanks were also adapted for flotation. The geometry of the tank had a significant effect on removal efficiency. A heterodispersed floc size distribution was always deleterious to the sedimentation process, but could be compensated for in flotation. Generally, long shallow tanks were more tolerant of non-optimal coagulation and floc formation.

Germany

### 95-0906

#### **Optimal control of ground-water quality management: non-linear programming approach.**

S. A. TAGHAVI (Montgomery Watson Sacramento Calif.), R. L. HOWITT, and M. A. MARINO

*Journal of Water Resources Planning and Management*, 1994, 120, No 6, 962-982

A non-linear programming-based mathematical model was developed for providing optimal control for managing the generation and disposal of agricultural and dairy waste. The model used a state response matrix to represent the response of the physical state of the system and a policy response matrix to describe the effect of policy actions such as pumping, recharge and manure disposal on the system. The dynamic response of the system was included as an explicit part of the optimization. The model applicability was demonstrated in the Chino groundwater basin, Calif. Based on the alternative scenarios, a manure treatment and disposal programme coupled with an artificial recharge programme are proposed. U.S.A.

95-0907

**Dairy manure influence on soil and sediment composition: implications for phosphorus retention.**

W. G. HARRIS (Florida University, Gainesville), H. D. WANG and K. R. REDDY

*Journal of Environmental Quality*, 1994, 23, No 5, 1071-1081

Dairy manure could increase phosphorus levels in the soil. The fate of added phosphorus was dependent on the soil's potential for phosphorus assimilation into stable forms. Surface horizons from dairy-intensive areas in the Okeechobee basin, Fla., U.S.A., released phosphorus rapidly. The factors that affect phosphorus retention in these soils were investigated. Coarse fragments, sand, silt and clay were examined using optical microscopy, X-ray diffraction, scanning electron microscopy, energy dispersive X-ray analysis, electron microprobe analysis, thermogravimetry, density separation and selective dissolution techniques. The Ap horizons were dominated by quartz in coarser fractions and by non-crystalline materials composed principally of silicon in clay fractions. Lack of calcium-phosphorus minerals suggested that manure components inhibited crystallization of stable calcium-phosphorus, maintaining high phosphorus solubility. Elimination of the barriers to calcium-phosphorus crystallization could greatly reduce phosphorus leaching from dairy affected surface horizons. There are 62 references. U.S.A.

95-0908

**Combined treatment of olive mill effluent and municipal wastewater in a small tourist community.**

F. C. ROCE (StudioAmbiente, Palermo), S. POULSON and D. W. HENDRICKS

*Water Science & Technology*, 1994, 29, No 9, 105-110

Treatment of olive mill wastewater was carried out at an activated sludge plant serving a village of population 7500 which rose to 15 100 in summer through tourism. Olive wastewater was produced from October to December, a volume of 3750 m<sup>3</sup> per year, a concentration of 40 g BOD per litre, and a load of 150 000 kg BOD per year. The plan was to upgrade the treatment plant to handle the tourist seasonal load. The olive mill wastewater would be stored in aerated tanks and fed to the plant outside the tourist season. The storage tanks could also function as aerobic digesters for excess sludge. Careful acclimatization of the activated sludge was necessary at the start of the olive season. Italy

95-0909

**Fish processing wastewater treatment requirements by line production changes.**

P. BATTISTONI (Ancona University) and G. FAVA

*Water Science & Technology*, 1994, 29, No 9, 111-119

The behaviour of a plant treating effluents from the processing of frozen fish, freshly harvested clams and some pre-fried cod was studied during 1988-1993. The treatment consisted of balancing, oil removal, then passage through a denitrification tank and an aeration tank followed by sedimentation and chlorination of the effluent. Sludge was thickened and dewatered. The wastewater was of low strength with a relatively high nitrogen content. Oil concentrations below 50 mg per litre caused no difficulties and a plant with a load of 0.25 kg BOD per m<sup>3</sup> d operated satisfactorily. If sludge retention time was kept at 30-40 d, sludge density was acceptable. Italy

95-0910

**Design of pre-acidification reactors for the anaerobic treatment of industrial wastewaters.**

I. F. ALEXIOU (Newcastle upon Tyne University), G. K. ANDERSON, and I. M. EVISON

*Water Science & Technology*, 1994, 29, No 9, 199-204

Two stage anaerobic digestion was investigated for treating brewery, dairy, coffee and slaughterhouse wastewaters. Optimal conditions of 37°C and pH 6 were established by laboratory and pilot plant experiments for the first, pre-acidification reactor. Hydraulic retention time (HRT) and nutrient addition had to be determined for each wastewater. HRT could be as low as 4 h. The pre-acidification stage was a valuable treatment provided complete acidification was avoided and only 40-50 per cent acidified matter was fed to a methanogenic reactor. The use of pre-acidification tanks is economic for biological nutrient removal. The degree of acidification and the percentage of acidified COD are proposed as alternatives to volatile fatty acid concentrations for assessing the efficiency of acidogenesis. U.K.

95-0911

**Evaluation of two upflow anaerobic digesters purifying industrial wastewaters high in organic matter.**

A. R. HOWGRAVE-GRAHAM (Natal University

Pietermaritzburg), H. A. ISHERWOOD and F. M. WALLIS

*Water Science & Technology*, 1994, 29, No 9, 225-229

The granular sludges in a clarigester purifying maize wastewater and those in an upflow anaerobic sludge blanket (UASB) unit, treating brewery effluent at 10 times the load of the other reactor relative to total suspended solids, were compared for activity and microbial population. The clarigester granules contained hydrolytic, acidogenic and acetogenic bacteria with *Methanotrix* and *Methanovibrio* the predominant methanogens. The UASB reactor granules contained a more uniform population, the major methanogens being *Methanotrix* and possibly *Methanobacterium*. The observations indicated that the creation and maintenance of resilient anaerobic digester granular sludge in upflow digesters was possible with a range of substrates and operating conditions. South Africa

95-0912

**An investigation into pre-treatment of dairy wastewater prior to aerobic biological treatment.**

B. KASAPGIL (Newcastle upon Tyne University), G. K. ANDERSON, and G. INCE

*Water Science & Technology*, 1994, 29, No 9, 205-212

Dissolved air flotation and anaerobic digestion were investigated in pilot plants as pre-treatments of dairy wastes. The former did not remove sufficient suspended solids and BOD to allow the subsequent aerobic stage to reach consent conditions. Anaerobic digestion in a packed upflow filter at 32-34°C and pH 6.8-7.2 achieved 90 per cent BOD removal with a hydraulic retention time of 20 h. The system was stable up to a loading of 6 kg COD per m<sup>3</sup> d. Reductions of this order would enable the aerobic treatment to meet consent conditions. U.K.

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95-0913

### Treatment of strong wastewaters by fixed bed anaerobic reactors with organic support.

A. GIITONAS (Aristotle University Thessaloniki), G. PASCALIDIS and A. ZOUBOULIS

*Water Science & Technology*, 1994, 29, No 9, 257-263

The treatment of a milk based synthetic waste of 10 g TOC per litre was studied in a 10.7 litre downflow reactor filled with straw as support for the anaerobic micro organisms. Hydraulic retention times of 2, 12 h, temperature of 15, 25 and 35°C and loads of 0.5-4.0 kg COD per m<sup>3</sup> were explored. The unit operated in plug flow mode. It could treat a wide range of wastewater concentrations. Low concentrations were treatable even at 15°C but little biogas was produced at this temperature. At high wastewater concentrations treatment arose from biodegradation and mass filtration in the organic support which eventually clogged, obliging renewal after 18 months. The method had the simplicity and flexibility to be potentially useful in small agricultural units. Efficiency and kinetic data are provided. (Greece)

95-0914

### Investigations into the composting of flotage from slaughterhouse effluents

F. SCHUCHARDT (Bundesforschungsanstalt für Landwirtschaft (FAL) Braunschweig) and A. TIERMAIER

*Korrespondenz Abwasser*, 1994, 41, No 10, 1812-1814 and 1816-1818 (in German, English summary)

Problems connected with the disposal of slaughterhouse wastes are considered, including the co-composting of the tailings produced by a flotation separation treatment with other residues. The characteristics and chemical composition of various wastes are compared, including those from the live animal holding area, the gastrointestinal contents and the effluent treatment residues. By combining the flotation tailings of low solids but relatively high nitrogen content with other residues of a carbonaceous type, a fermentable mixture suitable for composting could be obtained. The progress of the composting process was monitored under controlled conditions and it was demonstrated that a hygienically acceptable compost could be produced after 7-8 weeks of aerobic decomposition from mixtures of tailings with rumen contents in the ratio 1 to 0.94 and with straw from the bedding area in the ratio of 1 to 0.22. Composting in windrows would be the most economic method of treatment after a preliminary rotting period of 7-14 d in an enclosed vessel. (English translation 250 pounds sterling, valid for 1995). (Germany)

95-0915

### Anaerobic treatment of sulphate-containing distillery effluent

F. A. STADLBÄUER (Fachhochschule Gießen-Friedberg), E. N. OEFY and B. WILBER

*GWA Wasser/Abwasser*, 1994, 135, No 10, 590-594 (in German, English summary)

A pulsed recirculating fluidized bed reactor and a pulsed anaerobic filter connected in series were subjected to a process evaluation study as a method of anaerobic digestion of high strength distillery wastewater composed of cherry slops with a sulphate content of 2 g per litre. The high level of sulphate and the presence of copper (150-200 mg per litre) had a marked inhibitory effect on the decomposition reaction with the result that only 40-50 per cent COD elimination was achieved. Further trials were conducted with a pulsed anaerobic cascade reactor system comprising a series of 8 reaction compartments, in which sulphate-reducing bacteria were present in the first 4 cells. However, there was only a slight improvement in the diges-

tion performance and a steady state COD reduction of sufficient magnitude could not be reliably achieved. As a result, the use of lactic acid in place of sulphuric acid for assisting the process of cherry fermentation is proposed. The presence of copper was associated with the detoxification of the cyanide containing materials of natural origin, due to the formation of a stable complex ion. The replacement of copper sulphate by copper acetate is also advocated as a method of reducing the sulphate content. (English translation 135 pounds sterling, valid for 1995). (Germany)

95-0916

### Kinetic study of anaerobic digestion of brewery wastewater.

R. BORJA (Instituto de la Grasa y sus Derivados (CSIC) Sevilla), A. MARTÍN, M. M. DURÁN, M. LUQUE, and V. ALONSO

*Process Biochemistry*, 1994, 29, No 8, 645-650

The brewery wastewater was treated in completely mixed, continuous flow bioreactor operating at 35°C using a saponite immobilized biomass at a concentration of 6.2 g volatile suspended solids (VSS) per litre. Guot's kinetic model was used to determine the macroenergy parameters in terms of the true yield coefficient for the biomass and the specific rate of substrate uptake for cell maintenance. Over a hydraulic detention period ranging from 1.25 to 10 d, the COD removal efficiency varied only very slightly from 95.4 to 98.5 per cent. Similarly, the VSS concentrations in the effluent varied between 0.03 and 0.01 g per litre at identical hydraulic detention periods. The model predicted the behaviour of the reactor very accurately and the parameters reflected the activity of the micro organisms during the anaerobic digestion of the wastewater. (Spain)

95-0917

### Phenol conversion and dimeric intermediates in horseradish peroxidase-catalysed phenol removal from water

J. YU (Windsor University, Ont.), K. I. TAYLOR, H. ZOU, N. BISWAS, and J. K. BIWIRA

*Environmental Science & Technology*, 1994, 28, No 12, 2154-2160

The products of phenol polymerization at pH 7 in the presence of horseradish peroxidase, hydrogen peroxide and polyethylene glycol (PEG) were investigated by high performance liquid chromatography, thin layer chromatography, nuclear magnetic resonance and gas chromatography-mass spectrometry. The reaction was stopped by reducing the pH below pH 2 with phosphoric acid. Dimers were intermediates, their decreasing order of specific reaction rates with peroxidase was *p*-phenoxyphenol, *p,p'*-biphenol and *o,p'*-biphenol. The remainder of the polymer precipitate consisted principally of compounds of higher hydrophobicity and molecular mass. For an equimolar ratio of phenol to hydrogen peroxide, the phenol polymerization was first order in phenol concentration. A peroxidase inactivation model for the reaction in the presence of PEG was proposed. The inactivation rate constant bore a logarithmic relationship with the ratio of PEG to enzyme doses. (Canada)

95-0918

### Preparation of membrane-immobilized enzymes for phenol decomposition.

M. BODZEK (Silesia Technical University, Gliwice), J. BOHDZIEWICZ and M. KOWALSKA

*Journal of Chemical Technology & Biotechnology*, 1994, 61, No 3, 213-239

The biodegradation of phenols was studied using an enzyme fraction (from bacterial strains present in activated sludge) immobilized on flat membranes fabricated from non-cellulose polymers (polyacry-

lonitrile, polyvinyl chloride and polysulphone). In practice, the enzymes were absorbed onto the membrane surface, which retains the whole protein, following ultrafiltration of enzyme solutions by the membranes. This procedure forms a gel layer that adheres to the membrane surface. The results suggest that the phenol degradation efficiency reached 80 per cent at an 8 mmol per dm<sup>3</sup> phenol concentration in wastewater with a PAN-13 (polyacrylonitrile) membrane and with an ultrafiltration retention coefficient in excess of 87 per cent. **Poland**

95-0919

**Radiation degradation of waste waters: I. Reverse phase-high performance liquid chromatography and multicomponent UV-VIS analysis of gamma-irradiated aqueous solutions of nitrobenzene.**

J. KURUC (Comenius University Bratislava), M. K. SAHOO, J. LUCKAJ and M. HUTTA

*Journal of Radioanalytical and Nuclear Chemistry*, 1994, **183**, No 1, 99-107

The radiolysis products of deaerated saturated aqueous solutions of nitrobenzene (0.1 M nitric acid, 0.1 M potassium hydroxide, irradiated with cobalt-60 gamma-rays) were analysed using RP-HPLC and multicomponent UV-VIS spectrometry. The retention times of the radiolytic products were identical with those of isomeric nitrophenols, aminophenols and dinitrophenols. Ten standards and 11 wavelengths for multicomponent UV-VIS analysis (linear multiparametric regression analysis) were selected (from literature and RP-HPLC data) for use in the determination of concentrations of reactants and products in the solutions. Radiation chemical yields ( $G$  values, molecules per 100 eV) of the radiolytic products and decomposition of nitrobenzene in aqueous solutions ( $G$  nitrobenzene) were calculated from the dependence of concentrations with dose. pH had little influence on the decrease of nitrobenzene concentration but strong influence on the product composition. **Slovak Republic**

95-0920

**AOX removal and AOX formation in response to oxidation with hydrogen peroxide/iron(II) and hydrogen peroxide/UV.**

J. RUTXIPH (Bayer AG, Leverkusen)

*Korrosionstechnik*, 1994, **41**, No 10, 1794-1796 and 1798-1801 (in German, English summary)

During the oxidative treatment of effluents by hydrogen peroxide in conjunction with ferrous ions or ultraviolet irradiation as a means of eliminating AOX and halogenated compounds, it was possible for new AOX compounds to be formed, with the result that the residual levels of AOX specified under certain loadings in connection with effluents discharged to stream could not be complied with. Experiments were carried out with a number of test solutions containing either para-chlorophenol or phenol to determine the balance of AOX formation and removal during treatment with hydrogen peroxide and to compare the effectiveness of ferrous ions and ultraviolet irradiation for the overall reduction of residual AOX concentrations. The effects of pH and intensity of irradiation were examined, from which it was inferred that the formation of new AOX compounds could be suppressed by a correct choice of pH in conjunction with the use of ultraviolet irradiation in place of ferrous ions. Where newly formed AOX compounds must be eliminated this could be achieved by high intensity irradiation in the presence of hydrogen peroxide. (English translation 275 pounds sterling, valid for 1995). **Germany**

95-0921

**A kinetic model of a recirculated upflow anaerobic sludge blanket treating phenolic wastewater**

T. C. WEN (National Cheng Kung University, Tainan), S. S. CHENG and J. J. LAY

*Water Environment Research*, 1994, **66**, No 6, 794-799

Biokinetic models are useful in designing and operating anaerobic biosystems for wastewater treatment. Sludge from a recirculated upflow anaerobic sludge blanket (RUASB) reactor treating phenolic wastewater at organic loadings of 6-20 kg COD per m<sup>3</sup> d was tested by the biochemical methane potential (BMP) method at intervals over 5 years to accurately determine the specific gas production rate. A regression procedure that includes plotting, specification, fitting, diagnosis, residual analysis, scientific explanation, and model prediction was proposed in the selection of a model with statistically significant parameters for the RUASB treatment of phenolic wastewater. A modified version of the Haldane model was selected and its parameters verified to be statistically significant. BMP tests with sludge taken from the RUASB bioreactor running at a loading of 14 kg COD per m<sup>3</sup> d validated the effectiveness of the selected model through comparisons of experimental data and predictions of maximal specific reaction rate, saturation constant, inhibitor constant, and the order of inhibition. **Taiwan**

95-0922

**Activated carbon adsorption of phenolics in oak systems: effect of pH and temperature variations.**

G. NAKHLE (King Fahd University of Petroleum & Minerals, Dhahran), N. ABU ZAHED and S. FAROOK

*Water Environment Research*, 1994, **66**, No 6, 842-850

The impact of solution pH and temperature on the enhancement in sorption capacity of activated carbon attributed to adsorbate polymerization was studied. Isotherm studies were conducted for phenol and *o*-cresol at room temperature and pH 3, 7, and 11 in oxic and anoxic conditions and at neutral pH and 8, 21, and 35°C. The adsorbate phase was characterized, and the extent of polymerization studied by GC/MS. A pH of 3 favoured physical adsorption but enhancement in sorption retention capacity was highest at pH 11. The optimal pH for adsorption of phenolics under oxic conditions was pH 7. The anoxic capacity of phenol and *o*-cresol increased with decreasing temperature and was highest at 6°C. Adsorption enhancement due to polymerization was highest at 35°C. Oxic isotherm capacities were relatively independent of temperature, suggesting that the positive and negative impacts of temperature on chemical reactions and physical adsorption tended to balance. The capacity of activated carbon could be increased by more than 2-fold by changing pH and temperature. **Saudi Arabia**

95-0923

**Development of a pretreatment programme to improve biological treatability of high strength and toxic industrial wastewater**

A. BRENNER (Ben-Gurion University of the Negev, Sede Boqer Campus), S. BILKIN and A. ABUHOVICH

*Water Science & Technology*, 1994, **29**, No 9, 29-37

A protocol was formulated for the pre-treatment of wastewaters from several chemical companies on an industrial estate, some of the effluents were toxic. The procedure began with the chemical and toxicological characterization of each waste stream, toxicity was measured by the Microtox test. The removal of contaminants by biodegradation, volatilization and powdered activated carbon adsorption was then estimated by screening tests. Effluents were clas-

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sified as biodegradable, subject to air stripping toxic or poorly biodegradable. The most economical combination of general biological treatment and waste segregation could be identified from these data. A specific application of the approach is provided Israel

95-0924

**Preoxidation of chlorophenolic wastewaters for their subsequent biological treatment.**

Y. H. YU (National Taiwan University Taipei) and S. T. HU  
*Water Science & Technology* 1994, 29, No 9, 313-320

The degradation of 500 mg per litre solutions of various chlorophenols by ozone and activated sludge was studied in an 8 litre ozonator and aeration systems of either fill and-draw or shake-plate types. Ozone degraded 15-35 per cent of the chlorophenols, di- and tri-chlorinated undergoing the greatest destruction although this was not reflected in COD measurements. Degradation was 5-10 per cent greater at pH 10 compared with pH 3. Pre-ozonation solutions were much more effectively biodegraded by unacclimatized activated sludge than untreated solutions. However, activated sludge which had acclimatized to untreated chlorophenolic solutions was slightly retarded by a few per cent when treating pre-ozonated solutions. Reductions in feed concentration and some inhibition by ozonated products could be the explanation. Taiwan

95-0925

**Lanstar claims breakthrough for wastewater treatment technology.**

*Water Services* 1994, 98, No 1186, 26

A destruction technology was developed for the treatment of waste water containing aromatic chemicals which completely removed colour, odour and toxicity. COD was reduced by 70-80 per cent. The COE Process (Catalytic Oxidation of Effluents) could be carried out on a batch basis using conventional chemical reactors. It used a recyclable heterogeneous catalyst which avoided the problems of Fenton's reagent. The process was being used to treat nitrophenol cresol effluent. U.K.

95-0926

**Treatment of effluents from hemp-based pulp and paper industry. I. Waste characterization and physico-chemical treatability.**

F. B. DILLIK (Middle East Technical University Ankara) and C. F. GOKCAY

*Water Science & Technology* 1994, 29, No 9, 161-163

The nature of the waste and its physico-chemical treatability were studied for hemp-based pulp and paper effluents. Chemical treatment was examined by jar tests using alum as coagulant. COD removals were 96-50 and 20 per cent for the paper machine alkali extraction and bleaching effluent, respectively. Colour reduction was around 80 per cent (see also following abstract). Turkey

95-0927

**Treatment of effluents from hemp-based pulp and paper industry. II. Biological treatability of pulping effluents.**

C. F. GOKCAY (Middle East Technical University Ankara), and F. B. DILLIK

*Water Science & Technology* 1994, 29, No 9, 165-168

Hemp based pulp and paper effluents were biologically treated with a white rot fungus *Phanerochaete chrysosporium* at 35°C in 500 ml shake flasks with a nutrient medium containing glucose. Tests were in 2 cycles of 9 and 3 d. After the first incubation, half the supernatant

was poured off and replaced with kraft liquor and different combinations of the decolorizing medium. Glucose, COD and colour were measured every 24 h. Colour removal from the pulping effluents increased with the concentration of glucose, reaching 75 per cent (see also preceding abstract). Turkey

95-0928

**Paper mill effluent decolorization by fifty *Streptomyces* strains.** M. HERNANDEZ (Universidad de Alcalá de Henares, Madrid), J. RODRIGUEZ, J. SOLIVERI, J. L. COPA, M. I. PEREZ, and M. E. ARIAS

*Applied and Environmental Microbiology* 1994, 60, No 11, 3909-3913

Optimal conditions for the removal of colour from a paper mill effluent by *Streptomyces* strains were investigated. From 50 actinomycete strains isolated from different lignocellulosic substrates, 5 *Streptomyces* strains were selected for their decolorization ability in a liquid medium. The highest levels of decolorization achieved were 60-65 per cent. Fractionation of the resulting effluent by gel permeation chromatography showed reductions in the level of absorbance of high and medium molecular-weight compounds which were principally responsible for the colour of the effluent. The remaining low molecular weight compounds were probably responsible for the residual colour. Spain

95-0929

**Characterization of textile wastewaters: a review.**

V. M. CORREIA (Cranfield University Bedford), T. STEPHENSON, and S. J. JUDG

*Environmental Technology* 1994, 15, No 10, 917-929

The diversity of raw materials and production processes used in the textile industry results in a high volume of wastes that are extremely variable in composition and which may include non-biodegradable dyes and toxic substances. Identifying suitable end of pipe treatment processes is made difficult by the combining of effluent streams from individual processes which cause large daily variations in the effluent chemical composition. Potential waste treatment procedures should be dedicated to individual process effluents rather than the combined discharge in order to be reliable and efficient. However, this is not viable in real plant situations since the capital cost would be prohibitively high. It seems likely that individual wastewater stream treatment technologies would be employed where the discharge consents are stringently enforced and/or the treated effluent has some value. There are 36 references. U.K.

95-0930

**Role of oxygen at the TiO<sub>2</sub> interface during photodegradation of biologically difficult-to-degrade anthraquinone-sulphonate dyes.**

J. KIWI (Ecole polytechnique Fédérale de Lausanne)

*Environmental Toxicology and Chemistry* 1994, 13, No 10, 1569-1575

The photolytic decomposition of anthraquinone sulphonate sodium salt (ASS) in a suspension of titanium dioxide was examined at 30°C and 60°C under aerobic conditions. The presence of oxygen enhanced the degradation rate. Increased decay rates were observed for the addition of hydrogen peroxide and for tests run at 60°C. Production of hydrogen peroxide was enhanced by increased pH. Increasing the concentration of titanium dioxide in the suspension generated increased amounts of hydrogen peroxide due to the increased availability of surface states. The observed rate for hydrogen peroxide production decreased with increased concentrations of isopropanol.

a hole scavenger, which pointed to an oxidative route to the production of hydrogen peroxide. The photodegradation of ASS was an indirect result of light mostly absorbed by the titanium dioxide and demonstrated a possibility for the treatment of dyestuff effluent with semiconductor suspensions. Switzerland

95-0931

**New clarifying process solves textile effluent colour problem**

A. TIMMONS (The Clean Water Company Ltd, Batley) and M. J. AINSWORTH

*Water & Wastewater International*, 1994, 9, No 5, 54

Incorporation of a tangential flow separator (TFS) in the treatment of effluent from a textile company achieved complete removal of colour, 93 per cent reduction in suspended solids and a halving of COD. Principles of operation of the TFS are briefly described. Advantages of TFS include compact size, stable treatment conditions and a dried waste product. U.K.

95-0932

**Pretreatment of textile industry wastewaters with ozone**

M. IZITZI (Patras University), D. V. VAYENAS and G. LYBERATOS

*Water Science & Technology*, 1994, 29, No 9, 151-160

Textile industry wastewaters, as raw water and after coagulation/precipitation, were treated with ozone in laboratory batch or continuous reactors at 20-25°C for 5-60 minutes. The most effective colour removal exceeding 80 per cent was achieved by coagulation/precipitation followed by ozonation. A mathematical model was developed whose variables were absorbance, COD and residual ozone concentration in the liquid. It assumed that the wastewater organic compounds were either coloured or colourless and reacted differently. The model was verified with the experimental data and proved very satisfactory. The formulation of the model is described in detail. Greece

95-0933

**Membrane separation of wool scour effluent**

J. BILSTAD (Rogaland University Centre, Stavanger), I. ISPEIDAL and M. MADLAND

*Water Science & Technology*, 1994, 29, No 9, 251-256

The wastewater from the washing of raw wool at 55°C with high pH detergents, often with a COD concentration near 100 000 mg per litre, was treated by ultrafiltration. The modular tubular polyether sulphone membrane configuration, based on pilot plant results, operated as a batch process with 31 m<sup>2</sup> membrane area. The feed temperature was kept above 40°C to avoid problems with fat. Volume was reduced 10 times, the retained effluent was returned to the feed tank and the permeate discharged to the sewer through a heat exchanger. Sludge was transported weekly to a lagoon for dewatering. The plant required 2 h maintenance per d with yearly replacement of membranes. COD, fat and solids reduction were constantly above 80 per cent. Norway

95-0934

**Treatability studies and process design for toxicity reduction for a synthetic fibre industry**

J. L. MUSTERMAN (Eckenfelder & Binnie Ltd, Redhill, U.K.) and T. H. FLIPPIN

*Water Science & Technology*, 1994, 29, No 9, 297-306

The removal of ethylenediamine (EDA) from synthetic fibre effluents was investigated in the laboratory. Batch tests with air stripping, granular activated carbon, macroreticular resin, activated silica cat-

ion exchange resin and aerobic biological treatment indicated that the last 2 processes only were likely to reduce toxicity. Continuous activated sludge treatability experiments were conducted at winter and summer temperatures. A completely mixed nitrifying activated sludge at a loading of 0.1 g BOD per g mixed liquor suspended solids and 10°C gave an effluent of 250-200 and 25 mg per litre for BOD, total suspended solids, ammoniacal nitrogen respectively, which caused less than 2 per cent mortality of *Ceriodaphnia dubia*. Performance was stable for carbonaceous removal and nitrification with influent TDA of 530-1130 mg per litre. Ammonia emissions did not exceed the regulatory standard of 0.17 pounds ammonia per 15 minutes. U.S.A.

95-0935

**Pretreatment requirements for leather tanning industry wastewaters**

O. ILINAY (Istanbul Technical University), D. ORHON and I. KABDASI

*Water Science & Technology*, 1994, 29, No 9, 121-128

Efficiency of alternative schemes of physical/chemical treatment were investigated for leather wastewaters from 2 tanneries processing cattlehide. Sulphide was oxidized in the presence of a manganese(II) catalyst, followed by carbonation with carbon dioxide, flocculation with ferric chloride. Protein was reduced by settlement in 1 d at low pH with ferric chloride and anionic polyelectrolyte. The effects of these processes were compared with sedimentation alone and chemical precipitation with ferric chloride, lime and anionic polyelectrolyte. Carbonation and protein removal had little effect on COD, protein precipitation eliminated 20 per cent of Kjeldahl nitrogen. Sedimentation was as effective as chemical precipitation for all parameters except chromium. Physical/chemical treatment and chemical precipitation seemed necessary for meeting pre-treatment standards and removing chromium. Considerable detail is provided. Turkey

95-0936

**Pretreatment of tannery wastewaters**

I. TALINLI (Istanbul Technical University)

*Water Science & Technology*, 1994, 29, No 9, 175-178

The treatability of tannery wastewater of mean COD 8000 mg per litre was investigated in jar tests with alum, ferric chloride, lime and combinations of these coagulants, all with non-ionic polyelectrolyte. 63 per cent removal was achieved with polymer and 2000 mg lime per litre. Other chemicals gave inferior results. Further treatment was provided by an extended aeration plant with a hydraulic retention time of 2 d. This reduced the COD to 650 mg per litre, which was within the required value. Total sludge production was 2.5 kg per m<sup>3</sup> of water treated. Turkey

95-0937

**Utilization of wastewater from fertilizer industry - a case study**

S. T. ABOL-ELELA (National Research Centre, Cairo) and N. ABDEL-MONEM

*Water Science & Technology*, 1994, 29, No 9, 169-173

In plant control of water was implemented within a superphosphate fertilizer factory. The major source of pollution was the scrubbing of the silicon fluoride gas resulting from the mixing of phosphate and sulphuric acid. A closed circuit scrubbing system reduced waste water amounts by 40 per cent. The hexafluorosilicic acid from the tower was treated with sodium chloride to yield sodium hexafluorosilicate which was saleable. These modifications reduced



## INDUSTRIAL EFFLUENTS

cost. The remaining unwashed residue, which was highly acidic, was diluted with waste cooling water. **Egypt**

95-0938

### Biological treatment of photoprocessing wastewaters.

S. G. PAVLOSTATHIS (Georgia Institute of Technology Atlanta) and S. A. JUNGLE

*Water Science & Technology* 1994, 29, No 9, 89-98

Simulated photoprocessing wastewater from 2 commonly used colour processes were treated in fill-and-draw laboratory activated sludge reactors at loadings of 10-100 per cent in a synthetic feed. Up to 68 per cent of the COD in the photoprocessing wastewater was removed. The addition of alkali was necessary as pH fell with the oxidation of sulphite and thiosulphate. Ammonia was oxidized in all cases although there were some reactors in which nitrite accumulated. Semi-continuous digesters were fed with activated sludge arising from the treatment of wastewater. Performance was at least equal to that of the control when the activated sludge had arisen from feed containing 50 per cent of the simulated wastewater. Loss of gas production, low pH and increased volatile fatty acids occurred only when the activated sludge had received a 100 per cent feed. Recovery took place after prolonged incubation. Advanced chemical oxidation and biological treatment were appropriate to these wastewaters. **U.S.A.**

95-0939

### Anaerobic treatment of industrial wastewater containing organic solvents

I. FIRZIS (Bradford University)

*Water Science & Technology* 1994, 29, No 9, 321-329

The anaerobic digestion of propan-2-ol taken as an example of organic solvent in an industrial wastewater, was studied in laboratory anaerobic digesters stirred by magnets. After acclimatization, kinetic data were obtained by operating at several solid retention times and effluent substrate concentrations using different feed strengths and solids wasting rates. Steady-state conditions were judged by volatile solids concentration, effluent COD, gas production and gas composition. Once a suitable bacterial population was established, anaerobic digestion proceeded at 25-40°C, with 35°C being optimal. The likely reaction mechanism was through acetone and hydrogen to methane and carbon dioxide. Shock loads caused a rapid rise of hydrogen in digester gas. This measurement could provide an indication of incipient digester failure. **U.K.**

95-0940

### Ozonolysis of 2,4-dichlorophenol in a two-phase solvent/water system.

C. Y. CHANG (National Chiao Tung University, Hsinchu) and I. N. CHEN

*Water Science & Technology* 1994, 29, No 9, 343-346

A solution containing 2,4-dichlorophenol (DCP) was extracted by an immiscible fluorinated hydrocarbon and subjected to ozonation in a continuous apparatus in which the solvent was recycled through the ozonator. DCP was analysed in the aqueous phase by high performance liquid chromatography. Solvent extraction was swift, 30 per cent being removed in the first 10 minutes, then the DCP concentration declined in 3 h to about 48 per cent of its original value. The reaction with ozone was relatively slow and second order. **Taiwan**

95-0941

### The use of hollow fibre cross-flow microfiltration in bioaccumulation and continuous removal of heavy metals from solution by *Saccharomyces cerevisiae*.

D. BRADY (Rhodes University, Grahamstown), P. D. ROSE, and J. R. DUNCAN

*Biotechnology & Bioengineering* 1994, 44, No 11, 1362-1366

Performance data are presented on the use of serial batteries of cross-flow microfiltration (CFMF) based yeast bioaccumulators to reduce the concentration of toxic heavy metals in water. In the experimental work, the influent contained copper (as the chloride) and either cadmium or cobalt (both as the chlorides). Atomic absorption spectrophotometry was used to indirectly monitor the metal concentrations in the final effluent. The use of serial membrane-based bioaccumulation systems could improve the efficiency of heavy metal removal, with the added advantage that the CFMF-based bioaccumulation process was potentially less expensive than gel-immobilized biomass. An other advantage was that CFMF-based systems could be engineered on a large scale. **South Africa**

95-0942

### Chemostat studies on iron removal from ferric citrate medium by aerobic culture of *Aeromonas* sp.

R. GOPALAN (Indian Institute of Technology, Bombay) and H. VIJAYARAMANI

*Environmental Technology* 1994, 15, No 9, 895-900

Iron removal from ferric citrate medium by an iron-resistant strain (F16) of *Aeromonas* sp. isolated from industrial wastewater, was investigated in 2 litre batch and continuous reactors operated at 27-29°C, with hydraulic retention times of 36-72 h and feed iron concentrations of 100-650 mg per litre for 100 d. Iron removal efficiencies of 99 per cent were achieved with concurrent 76-90 per cent COD removal in chemostat cultures of strain F16 with a retention time of 72 h and a citrate medium containing ferric iron up to 650 mg per litre. **India**

95-0943

### Pretreatment of complexed metal wastewaters

O. TUNAY (Istanbul Technical University), I. KABDASLI and R. TASLI

*Water Science & Technology* 1994, 29, No 9, 265-274

The applicability of hydroxide precipitation to complexed metal wastewater using inorganic cations that might function as ligand sharing agents was investigated. The effect of calcium, iron(II), iron(III), manganese(II) and magnesium were examined theoretically for cadmium and copper with ethylenediaminetetraacetic acid and nitrilotriacetic acid as ligands. Metal solubilities were calculated by considering the composition of the wastewater. In the experiments, cadmium and copper were introduced in excess as solid phases. Metal determinations were by atomic absorption spectrophotometry. Experiments with iron(II) were conducted in anoxic conditions. Calcium was the only cation effectively binding the ligands and making hydroxide precipitation possible. Iron(II) and manganese(II) were ineffective because of rapid oxidation, while magnesium was partially effective but probably not adequate for pretreatment. Solubility products, stability constants and the species involved are tabulated. **Turkey**

95-0944

**Optimization for reduction/precipitation treatment of hexavalent chromium.**

J. W. PATTERSON (Patterson Associates, Inc., Chicago, Ill.), I. G. ASCA and Y. WANG

*Water Science & Technology*, 1994, 29, No 9, 275-284

Treatment conditions in a plant receiving wastewater containing chromium(VI) and reducing it with sodium metabisulphite at low pH followed by pH adjustment, precipitation of metals and clarification were optimized in laboratory experiments. Dilute, typical and strong wastewaters were evaluated. Titrations gave the sodium metabisulphite requirement for each wastewater and kinetic constants for the reaction were obtained. Control of oxidation/reduction potential was critical, virtually complete reduction being achieved by 350 mV, the reaction at pH 2 was completed in 1 minute. It was important to avoid an overdose of sodium metabisulphite since with a half-life of 2 h it could enter the effluent. Precipitation at pH 9 gave the lowest residual chromium for combined wastewater, sedimentation alone was probably insufficient to satisfy the discharge limit of 1 mg total chromium per litre. There appeared to be disagreement between chromium(VI) analyses recorded by a test kit on site and a commercial laboratory using a U.S. EPA method, U.S.A.

95-0945

**Watching the river's flow.**

H. RUSSELL

*New Civil Engineer*, 1994, No 1104, Water Supplement 4, 6

Experimental treatments being tried on the drainage from the defunct Wheal Jane mine in Cornwall, to avoid a repetition of the disastrous acidic and metallic contamination of the Carron river and Falmouth (Nov. 1991) are described. Three types of treatment were tested and compared: the first consisted solely of percolation through reed beds; the second offered a lime dosing and sludge settlement stage before reed bed treatment; the third offered an anoxic pre-treatment stage provided by a mixture of straw and cattle manure laid on a gravel bed above a limestone drain, again followed by reed beds. Quality monitoring was effected by sampling on the river upstream and downstream of the discharge. The active treatment was also being studied alongside the construction of the pilot plant, U.K.

95-0946

**Neutralization of acid mine water with calcium carbonate**

J. P. MARLE (CSIR, Pretoria) and P. du PLESSIS

*Water Science & Technology*, 1994, 29, No 9, 285-296

The neutralization of sulphuric acid-rich mine water was investigated in pilot cone-shaped and pipe-shaped fluidized bed reactors containing limestone graded by sieves of 0.15-4.00 mm. The upflow rate to fluidize each size was determined by the water flow to expand the bed by 20 per cent in a 4-cm diameter tube. A calcium sulphate crystallization reactor was located after the fluidized beds. Lime stone was fed to reactors as needed. A cone reactor allowed large particles to be fluidized and smaller particles not to be washed out. The treatment of iron-rich waters was investigated. Limestone was completely utilized when testing iron(III)-rich water, but only about 70 per cent was used in the presence of 600 mg iron(II) per litre. This was due to the accumulation of coated particles in the reactor. Contact times for complete neutralization could be 10 times longer in the presence of iron(II). The method was convenient because of low cost, the simplicity of dosing and the low solubility of limestone above pH 7, South Africa.

95-0947

**Effluent treatment using ion exchangers and adsorption resins.**

H. R. BROST, H. HOITMANN, T. MANN, I. HARTINGER, R. NAGEL and W. JUNG

*Korrespondenz Abwasser*, 1994, 41, No 10, 1802-1804 and 1806-1810 (in German, English summary)

The quality standards which must be complied with in respect of discharges by metal working companies prior to discharge to stream were specified in Annex 40 of the Waste Water Conservation Ordinance, which was published in September 1989. These necessitated very thorough elimination of heavy metals and other contaminants from the rinsing waters, spent plating solutions and other liquids emanating from the processes employed. Low residual contaminant levels necessitated the use of ion exchange resin or selective adsorbents under carefully controlled conditions. Several proprietary processes had been devised for achieving the appropriate effluent quality standards, including the SERVO Clean Flow, the Upcore and the Amberpack treatments. The nature of the various ion exchange resins and adsorbent compounds is reviewed and flow diagrams illustrating their mode of application for the elimination of a range of metallic ions from typical process effluents are presented. (English translation, 360 pounds sterling, valid for 1995), Germany.

95-0948

**Treatment of wastewater from flue gas cleaning**

M. VINDRI, P. E. Kruger Engineering, Soborg) and C. SUNDT

*Water Science & Technology*, 1994, 29, No 9, 307-312

The treatment of a waste water produced by dewetting the gypsum slurry resulting from the scrubbing of power station gas with lime slurry was studied in 2 full-scale plants. The first stage was the crystallization of gypsum to reduce supersaturation then the precipitation of heavy metals by sodium hydroxide, sodium sulphide and ferric chloride assisted by polyelectrolyte. The sludge was pressed, the liquid phase was sand filtered. In one plant granular activated carbon filtration was added to ensure complete removal of mercury and cadmium. Most mercury was removed with the fly ash and precipitated gypsum. The effluent still contained 150-300 mg nitrate per litre, which could be removed by an activated sludge denitrification process. The practicality of this was demonstrated in a pilot plant, Denmark.

95-0949

**Treatment of recalcitrant organic compounds in oil reclaiming wastewater by ozone/hydrogen peroxide and UV/titanium dioxide**

H. G. LUYAS (Hamburg Harbour Technical University), D. BOKKEFELMANN, I. HEIMERING, D. BAHNEMANN and I. SIKOLICOV

*Water Science & Technology*, 1994, 29, No 9, 129-132

Refractory organic compounds in a biologically treated oil reclaiming wastewater with a COD of 400 mg per litre were treated by 2 oxidative processes in laboratory experiments. Seventy per cent of COD elimination and enhanced biodegradability resulted from a 5 h UV/titanium dioxide exposure at pH 3. Ozonation was little affected by hydrogen peroxide. Over 47 minutes it reduced COD by 17 per cent and also improved biodegradability. Several oxidation products were identified by gas chromatography-mass spectrometry, Germany.

## INDUSTRIAL EFFLUENTS

95-0950

### Membrane advances offer pores for thought.

*Water Services* 1994, 98, No 1185 44 45

Membrane separation technology was a valuable and cost effective way of meeting new high water quality and environmental standards. A new series of membrane treatment systems was available for industries wishing to upgrade their treatment of oily water and whitewater effluents. U.K.

95-0951

### Technological strategies for protecting and improving the biological treatment of wastewater from a petrochemical complex

M. REBIHUN (Technion-Israel Institute of Technology, Haifa) and N. GALIL

*Water Science & Technology* 1994, 29, No 9 133 141

Wastewater treatment at petrochemical complexes is prone to disruption from sudden discharges, usually of phenolic compounds. Protection to the process and improved performance arose from several measures. A 15 000 m<sup>3</sup> off-line balancing tank was constructed to contain storm flows and unexpected concentrated streams. Oil separation was introduced and emulsions treated by dissolved air flotation with alum as flocculant. The resulting effluent was treated in aerated ponds, clarified with lime and reused in the recirculated water cooling system. This approach removed 90 per cent of the oil before the aerobic ponds and gave a satisfactory effluent. Israel

95-0952

### Identification of trace organics in a treated lubricating oil refinery wastewater

I. TOWS (Hamburg Harbour Technical University), G. ALBERS, H. GÜLYAS, H. P. FICKHOFF, M. REICH and I. SEKOULOV

*Water Science & Technology* 1994, 29, No 9 187 194

Wastewater from a lubricating oil factory was treated by parallel plate interceptor, balancing tanks, flocculation and sedimentation with ferric chloride and polyelectrolyte then biological treatment in a fixed bed upflow bioreactor containing clay spheres with forced aeration. Biomass was removed by an anthracite/gravel filter. There was an option for granular activated carbon filtration if shock loads occurred. Influent hydrocarbons were reduced from 0.8 to 0.1 mg per litre in the biotfilter. Gas chromatography-mass spectrometry analyses of 1,1,2-trichlorotrifluoroethane extracts showed monocycloalkanes were the major group, falling from an initial 590 to 65 µg per litre in the effluent. Only a few compounds were identified in the dichloromethane extracts of the effluent. The major components were 1-methyl-2-propylcyclohexane, 2-ethers and nitrogen containing heterocycles. Germany

95-0953

### Characterization of a biologically treated wastewater from oil reclaiming: recording of low molecular weight organics and estimation of humic substances

H. GÜLYAS (Hamburg Harbour Technical University), M. REICH and I. SEKOULOV

*Water Science & Technology* 1994, 29, No 9 195 198

Oil reclaimation wastewater was treated by neutralization, adsorption by activated sludge, flocculation, flotation and activated sludge with a hydraulic retention time of 5-7 d. The effluent of COD 300-500 mg per litre was extracted by dichloromethane at various pH values and analysed by gas chromatography. Humic acids were removed by a highly alkaline anion exchange resin, eluted and analysed photometrically. These constituted around 15 per cent of the COD.

Hydrocarbons absorbed on to the activated sludge. Polyethoxy compounds, carboxylic acids and their esters were detected in 2 wastewaters, while amines and amides were found in another. With few exceptions, detected compounds differed completely from sample to sample, reflecting the changing composition of the processed spent oils. Germany

95-0954

### Adsorption of radiocobalt on lead dioxide from aqueous solution.

H. AHMAD (Quaid I Azam University, Islamabad), M. AFZAL, M. SALEEM and S. M. HASANY

*Journal of Radioanalytical and Nuclear Chemistry* 1994, 181, No 1 117 129

With a view to finding a method for the removal of cobalt-60 from research and medical waste waters, the adsorption of cobalt on lead dioxide was investigated in relation to shaking time, amount of adsorbent, pH and adsorbate concentration. Data fitted with Langmuir, Freundlich and Dubinin-Radushkevich isotherms, and their corresponding constants were calculated. Interference studies showed that EDTA, tartrate, citrate, thiocyanate, oxalate, uranum(VI), aluminium(III), iron(III), chromium(III) and thorium(IV) drastically reduced cobalt adsorption under supposedly optimal conditions. The removal of these anions and cations prior to cobalt adsorption was necessary. To compare the adsorption behaviour of cobalt with other metal ions and to determine the selectivity of lead dioxide, KD values for different elements were measured. These values indicated that cobalt could be successfully separated from mercury(II), silver(I), tantalum(V), indium(III) and technetium(VII). There are 92 references. Pakistan

95-0955

### Radioactive waste treatment products studied by Mossbauer spectroscopy. II. Iron hydroxide precipitation systems

V. SPANU (Institute of Physics and Technology of Materials, Bucharest) and C. N. TURCANU

*Journal of Radioanalytical and Nuclear Chemistry* 1994, 181, No 1 189 200

Iron hydroxide precipitation is a widely used process for the treatment of low level radioactive wastes. Such treatment includes a number of processes such as precipitation, co-precipitation, adsorption, ion exchange and radionuclide trapping, all of which are directly dependent on the properties and structure of the iron precipitate. Mossbauer spectroscopy was used to characterize the iron hydroxide samples prepared in different experimental conditions simulating the radioactive waste treatment. Magnetic oxides (haematite or magnetite) partially affected by superparamagnetic relaxation were observed. The crystallization degree and particle size were dependent on the concentration and the order of addition of chemicals. Much smaller particles were precipitated with calcium hydroxide than with sodium hydroxide as neutralizing agent. Precipitation from iron salts (ferric chloride or ferrous sulphate) was faster with sodium hydroxide than with calcium hydroxide.

Romania

## EFFECTS OF POLLUTION

See also Abstracts 95-0653, 95-0679, 95-0681, 95-0682, 95-0687

## 95-0956

**Effects of salinity on the condition and survival of zebra mussels (*Dreissena polymorpha*).**

R. W. KILGOUR (Mackie and Associates Water Systems Analysis, Guelph, Ont.), G. L. MACKIE, M. A. BAKER and R. KEPPEL.

*Estuaries*, 1994, 17, No 2, 385-393

The tolerance of various life stages of zebra mussels (*Dreissena polymorpha*) to salinity was investigated using specimens collected from St. Clair lake, Ont. The potential for colonization of regions of the Hudson river which were heavily industrialized and consisted of fresh water for most of the year by zebra mussels was evaluated. The extent to which acclimation events in the river affected tolerance and the effects of salinity on the health or condition of adult specimens were also studied. Zebra mussels were able to acclimate to slowly changing salinities. The life stages most sensitive to salinity and most likely to limit distribution were identified. **Canada**

## 95-0957

**Abundance of marine resources in relation to dissolved oxygen in Long Island Sound.**

P. HOWELL (Connecticut Department of Environmental Protection, Old Lyme) and D. SIMPSON

*Estuaries*, 1994, 17, No 2, 394-402

The effects of low dissolved oxygen on finfish (American lobster *Homarus americanus*) and squid (*Loligo pealei*) were investigated in field conditions in western Long Island Sound. Bottom trawl catches taken throughout the sound were compared using several methods to correlate dissolved oxygen concentrations with species abundance and diversity. Both abundance and diversity decreased significantly with bottom dissolved oxygen levels. Abundance patterns for squid, bluefish and butterfish suggested that these species were among the most sensitive to hypoxia. Only one of the species examined, winter flounder, showed a decrease in mean length with dissolved oxygen. **U.S.A.**

## 95-0958

**The ecological effects of structural flood mitigation works on fish habitats and fish communities in the lower Clarence river system of south-eastern Australia.**

D. A. POLLARD (Fisheries Research Institute, Cronulla, N.S.W.) and J. C. HANNAN

*Estuaries*, 1994, 17, No 2, 427-461

Habitats affected and unaffected by flood mitigation works carried out in the lower Clarence river system of south-eastern Australia were compared. The ecological effects of these works on estuarine and freshwater fish communities were studied, with particular emphasis on commercially and recreationally important species. The principal aspects considered were the effects of the changes on salinity and fringing vegetation and the distribution and abundance of estuarine and freshwater fish. The works generally lowered the overall quality of available fish habitat by reducing fringing vegetation and increasing the intensity of land use in the surrounding area. There are 40 references. **Australia**

## 95-0959

**The effects of dredging on shell formation in the razor clam *Ensis siliqua* from Barrinha, southern Portugal.**

M. B. GASPAR (Instituto Portugues de Investigacao Maritima, Olhao), C. A. RICHARDSON and C. C. MONTEIRO

*Journal of Marine Biological Association*, 1994, 74, No 4, 927-938

The growth rate of the shell of *Ensis siliqua* from southern Portugal estimated from an analysis of the growth rings was slower (von Bertalanffy growth constant  $K$  equal to 0.27) than that determined from the annual narrowing of the internal microgrowth patterns present in the shell sections ( $K$  equal to 0.65). Both methods predicted a similar asymptotic length of 144.8 and 139.6 mm, respectively. The presence of a series of shell margin breaks consisting of deep clefts in the outer shell layer with sand grains embedded was attributed to repeated dredge damage. The frequency of the clefts increased with the size and age of the clams. The seasonal deposition of small clefts during June was less pronounced than those caused by dredge damage. There are 37 references. **Portugal**

## 95-0960

**Influence of waterway development on migrational characteristics of juvenile salmonids in the lower Willamette river, Oregon.**

D. L. WARD (Oregon Department of Fish and Wildlife, Clackamas), A. A. NIGRO, R. A. FARR and C. J. KUTSIN

*North American Journal of Fisheries Management*, 1994, 14, No 2, 362-371

Juvenile *Oncorhynchus* spp. were abundant in the lower Willamette river during spring, with radio-tagged juvenile *Oncorhynchus mykiss* and yearling *Oncorhynchus tshawytscha* migrating through the harbour in 1-3 d. There was no spatial pattern in the downstream migration of radio-tagged fish and no differences in behaviour among the developments. Habitats occupied by migrating juvenile *Oncorhynchus* in the undeveloped area differed from those available at developed sites. More of the predator *Psychocheilus oregonensis* were caught in areas without development but there was no difference in the frequency of *P. oregonensis* digestive tracts containing juvenile *Oncorhynchus* between developed and undeveloped areas. Suggestions for further research are given. **U.S.A.**

## 95-0961

**Examining land use influences on stream habitats and macroinvertebrates: a GIS approach**

C. RICHARDS (Minnesota University, Duluth) and C. HOST

*Water Resources Bulletin*, 1994, 30, No 4, 729-738

Relationships between land use patterns and the physical habitat of streams and their macroinvertebrate populations within similar sized catchments were investigated using geographic information systems (GIS). Eleven catchments along the northern shore of Superior lake, ranging from heavily forested to highly urbanized cover, were selected for the study. Available data on land use and land cover were quantified with a minimal mapping resolution of 16 ha. Stream habitat and morphological features were characterized at sample points within each stream. Relationships between macroinvertebrates and stream physical habitat and between habitat and land use patterns were analysed. Substrate characteristics and presence of coarse woody debris had the strongest correlations with macroinvertebrate abundance and diversity. Substrate characteristics also correlated with urban and agricultural land use. Housing density correlated with algal abundance. The primary relationship between

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land use and the quality of stream habitat was demonstrated from the use of readily available spatial data. There are 47 references. U.S.A.

### 95-0962

#### **Alterations in the tissue lipid profiles of *Lamellidens marginalis* under ambient ammonia stress.**

A. N. CHITTY (Sri Venkateswara University, Tirupati) and K. INDIRA

*Bulletin of Environmental Contamination and Toxicology* 1994, 53, No 5, 693-698

The effects of ammonium sulphate (10 and 176 mg per litre) on the tissue lipids of freshwater mussel (*Lamellidens marginalis*) were studied. The exposure time was 7 d. The lipid profiles of the mantle, gill, foot and hepatopancreas were determined. On exposure to 10 or 176 mg ammonium sulphate per litre, the total lipid content decreased in all the tissues except the mantle. The phospholipid content of all the studied tissues except hepatopancreas and foot at 10 mg per litre decreased on exposure to ammonium sulphate. The cholesterol content also decreased in mantle, gill and hepatopancreas on exposure to ammonium sulphate. The results suggested that metabolic utilization of total lipids, phospholipids and cholesterol was increased under ammonia stress. **India**

### 95-0963

#### **Chronic toxicity of ammonia to the amphipod *Ilyella azteca*, importance of ammonium ion and water hardness.**

U. BORG-MANN (Department of Fisheries and Oceans, Burlington, Ont.)

*Environmental Pollution* 1994, 86, No 3, 329-335

Amphipods were exposed to ammonia for periods of 6 weeks for adults and 10 weeks for young. Mortality, growth and reproductive rates were measured. The LC<sub>50</sub> were 0.77 mM and 0.75 mM for young after 10 weeks and adults after 6 weeks, respectively in tap water. Reproduction was reduced at concentrations down to 0.32 mM. When the pH was adjusted by addition of acid, chronic mortality was related to total ammonium ion rather than unionized ammonia. A reduction in hardness and other ions, when tap water was diluted to 10 per cent with distilled water, resulted in a significant mortality at 0.1 mM compared with 1 mM in tap water. **Canada**

### 95-0964

#### **Marginal bleaching of thalli of *Rhizocarpon* as evidence for acid rain in the Norra Storfjället, Sweden.**

W. C. MAHANEY (York University, North York, Ont., Canada)

I. WILSON, M. G. BOYER and R. G. V. HANCOCK

*Environmental Pollution* 1995, 87, No 1, 71-75

Recent lichenographic surveys in the foreland of the Syterbacken glacier in southern Lapland revealed crustose lichen with bleached dying and dead margins, although fruticose and foliose lichens appeared undamaged. Possible explanations were bedrock lithology, ice crystal blasting, long term snowbank cover, ultraviolet exposure and acid rain. Differences in the topography of affected lichens suggested that bedrock effects and snow damage were not major causative factors. Sulphur dioxide emissions have been shown to cause chlorophyll bleaching and plasmolysis in the algal component of lichen. Soil surface pH levels in the field area ranged from 3.3 to 4.5, showing that the area had been affected by acid rain. Other factors probably played a part. If the algal component was damaged by acid rain, the fungal component might be vulnerable to other effects such as ultraviolet light. **Sweden**

### 95-0965

#### **Concentrations of heavy metals associated with urban runoff in fish living in stormwater treatment ponds.**

K. R. CAMPBELL (St. Johns River Water Management District, Orlando, Fla.)

*Archives of Environmental Contamination and Toxicology* 1994, 27, No 3, 352-356

Redear fish (*Lepomis microlophus*) from stormwater ponds in Orlando, Fla., contained significantly higher concentrations of cadmium, nickel, copper, lead and zinc than those from natural lakes and ponds (controls). Largemouth bass (*Micropterus salmoides*) collected from stormwater ponds contained significantly higher concentrations of cadmium and zinc than those from controls. *L. microlophus* from stormwater ponds contained significantly higher copper concentrations than those from controls. There are 30 references. **U.S.A.**

### 95-0966

#### **Trace metals in gills of fish from the Arabian gulf.**

S. AL YAKOOB (Kuwait Institute for Scientific Research, Safat)

A. H. BOU OLAYAN and M. BAHLOUL

*Bulletin of Environmental Contamination and Toxicology* 1994, 53, No 5, 718-725

The accumulation of cadmium, chromium, copper, nickel and lead in gills of fish from areas along the western side of the Arabian gulf affected by an oil spill in 1991 was studied. Fish were sampled from 4 sites: north Abu Ali, south Abu Ali, Rennie Shoals and Qatar. Metal concentrations were determined by AAS. The average metal concentrations decreased in the following order: lead (6.25-11.37 µg per g), chromium (5.5-7.55 µg per g), copper (3.34-4.14 µg per g), cadmium (0.8-1.53 µg per g), nickel (0.2-0.47 µg per g). The highest average concentration of cadmium was observed from the Qatar station. Highest average concentrations of chromium, lead and nickel were observed in fish from north Abu Ali, south Abu Ali and Rennie Shoals, respectively. **Kuwait**

### 95-0967

#### **Exclusion of the Jefferson salamander, *Ambystoma jeffersonianum*, from some potential breeding ponds in Pennsylvania: effects of pH, temperature, and metals on embryonic development.**

M. T. HORNE (Pennsylvania State University, University Park) and W. A. DUNSON

*Archives of Environmental Contamination and Toxicology* 1994, 27, No 3, 323-330

Aluminium, sulphate, hydrogen and zinc ions were significantly higher in 40 ponds in central and northern Pennsylvania that lacked successful breeding of *Ambystoma jeffersonianum*, whereas alkalinity, copper, dissolved organic carbon, potassium, magnesium, sodium and nitrate ions were significantly higher in 10 ponds that supported successful breeding. In another set of ponds, aluminium, conductivity, hydrogen ions and silicon dioxide were significantly higher in 5 ponds lacking reproduction and alkalinity, calcium and potassium were significantly higher in 3 ponds with reproduction. Egg masses transplanted into ponds supporting viable *A. jeffersonianum* populations showed significantly greater survival and hatching which was greater at 15 than 10°C. Low pH slowed development rate and decreased hatching success of embryos at 10 and 15°C. Copper was acutely toxic to embryos at pH 4.5 but was not toxic in the field. Aluminium concentrations between 250 and 500 µg per litre greatly reduced mortality at pH 4.5. Aluminium, lead and zinc up to 2000

ug per litre did not affect development rate. There are 52 references. U.S.A.

95-0968

**Digestive lysosomes enlargement induced by experimental exposure to metals (Cu, Cd, and Zn) in mussels collected from a zinc-polluted site.**

M. ETXEBERRIA (Euskal Herriko Unibertsitatea, Bilbo), I. SASTRE, M. P. CAJARAVILLE, and I. MARIGOMEZ

*Archives of Environmental Contamination and Toxicology*, 1994, 27, No 3, 338-345

A field study in Spain showed that increasing environmental levels of bioavailable zinc were associated with enlarged digestive lysosomes in *Mytilus galloprovincialis*. When depurated in clean seawater for one week acclimation plus 6 experimental d, the digestive lysosomal size was reduced significantly. However after 20 experimental d, stress due to laboratory handling gave a reduced number of large digestive lysosomes. Subsequent exposure to zinc, copper and cadmium enlarged digestive lysosomes of zinc-polluted *M. galloprovincialis* beyond that produced in the field. There are 30 references. Spain

95-0969

**Mercury accumulation profiles and their modification by interaction with cadmium and lead in the soft tissues of the Cichlid *Oreochromis aureus* during chronic exposure**

P. ALLEN (National University of Singapore)

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 5, 684-692

The effects of exposure to combinations of mercury (0.05-0.2 mg per litre) with cadmium (0.1 and 0.5 mg per litre) or lead (0.5 and 0.05 mg per litre) on tissue (liver, brain, gill filaments, intestine, caudal muscle) accumulation of mercury in *Oreochromis aureus* were studied. Exposure to mercury alone caused significant increases in the mercury content of all tissues analysed. Under all exposure conditions caudal muscle accumulated less mercury than other tissues, except for exposure to 0.2 mg mercury per litre. Exposure to 0.05 mg cadmium per litre with 0.05 mg mercury per litre reduced caudal muscle mercury contents below 1 µg per g. Under these conditions a slight reduction in whole body mercury content was also observed. Mercury accumulation was particularly high in the liver and gill filaments. Singapore

95-0970

**Interactions between copper and cadmium during single and combined exposure in juvenile tilapia *Oreochromis mossambicus*: influence of feeding condition on whole body metal accumulation and the effect of the metals on tissue water and ion content.**

S. M. G. J. PELGROM (Nijmegen University), L. P. M. LAMERS, J. A. M. GARRIJSSEN, B. M. P. F. S. R. A. C. LOCK, P. H. M. BALM, and S. F. WENDELAAR BONGA

*Aquatic Toxicology*, 1994, 30, No 2, 117-135

Juvenile *Oreochromis mossambicus* exposed for 96 h to sublethal concentrations of copper or cadmium showed that exposure to one metal increased the whole body content of that metal and also influenced the concentration of the other metal present in the fish. The total amount of copper and cadmium accumulated during exposure was influenced by the nutritional state of the fish. Accumulation during copper/cadmium co-exposure could not be predicted by simple addition of the effects of single metal exposure, as there was significantly decreased whole body content of cadmium in co-ex-

posed fish compared to cadmium content of cadmium-exposed fish. This phenomenon was observed in fed and non-fed fish. Whole body water, calcium and sodium content in copper and/or cadmium-exposed fish also indicated that there was interaction between the 2 metals. There are 43 references. Netherlands

95-0971

**Lipid peroxidation in the gill and hepatopancreas of *Oriolatelphusa senex senex* Fabricius during cadmium and copper exposure.**

P. S. REDDY (Pondicherry University) and A. BHAGYALAKSHMI

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 5, 704-710

The effects of exposure for 7 d to sublethal concentrations of copper (100 µg per litre) and cadmium (100 µg per litre) on lipid peroxidation in the tissues of the edible freshwater crab *Oriolatelphusa senex senex* were investigated. The concentrations of copper and cadmium in the hepatopancreas and gill tissues were determined by AAS. Lipid peroxidation was evaluated by determining the levels of malondialdehyde (MDA) and glutathione in the tissues. The MDA concentration increased significantly in the tissues of copper-exposed crabs whilst exposure to cadmium had no effect on MDA content. Glutathione concentration decreased significantly following exposure to copper, but was not affected by cadmium exposure. Copper stimulated lipid peroxidation in crabs whereas cadmium did not. India

95-0972

**Using feathers to assess risk of mercury and selenium to bald eagle reproduction in the Great Lakes region**

W. W. BOWERMAN (Michigan State University, East Lansing, U.S.A.), E. D. EVANS, J. P. GILSY, and S. POSTUPALSKY

*Archives of Environmental Contamination and Toxicology*, 1994, 27, No 3, 294-298

An examination of the mercury and selenium concentrations in feathers of nestling and adult *Haliaeetus leucorhynchus* in the Great Lakes region showed a maximum of 66 mg mercury per kg in adult feathers in the upper peninsula of Michigan. The geometric means of mercury in adult and nestling feathers ranged from 13-22 and 3.7-20 mg per kg, respectively, in the areas sampled. Selenium concentrations were not significantly different across the regions nor between adult and nestling feathers, ranging from 0.8-3.2 mg per kg. There were no significant relationships between adult or nestling feather concentrations of mercury and selenium and measures of reproduction, productivity and nesting success. There are 37 references. North America

95-0973

**Structural and functional responses of a freshwater plankton community to acute copper stress.**

K. L. HAVENS (Kent State University, Ohio)

*Environmental Pollution*, 1994, 86, No 3, 259-266

Plankton were exposed to copper at concentrations of approximately 140 µg per litre for 14 d in 100 litre mesocosms *in situ* in a lake. The community structure was monitored on days 0, 2, 4, 7 and 14. Copper significantly reduced the dry weight biomass of total zooplankton, ciliates, flagellates and autotrophic phytoplankton, while the bacterial biomass increased 10-fold, probably because of reduced grazing and nutrient release from dying plankton. Carbon-14 labelled bicarbonate and glucose were used to assess transport of carbon in algal and bacterial pathways. Copper reduced the transport of carbon to the surviving zooplankton. Bacterial pathways were more impaired

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because zooplankton in the copper treatment could not utilize bacteria. There are 31 references. U.S.A.

### 95-0974

**Size-related variation in the sensitivity of the mussel, *Mytilus edulis*, to copper.**

K. HOARE (Wales University, Menai Bridge Bangor), and J. DAVENPORT.

*Journal of Marine Biological Association*, 1994, 74, No 4, 971-973.

Using a simple assay, the level of copper resistance found in *Mytilus edulis* veligers persisted in mussels of 1 mm shell length (400 ppb copper; LT50 12.5 d). The lower adult level of resistance was reached at shell length of 5 mm (400 ppb copper; LT50 2.8-5.3 d). Resistance to copper toxicity began to decline gradually after metamorphosis, being significantly correlated with shell length. Size differences explained 8 per cent of the variation in copper resistance among juvenile mussels. U.K.

### 95-0975

**The susceptibility of superoxide dismutase in *Lemna minor* to systematic copper concentrated from wastewater.**

J. A. BUCKLEY (Washington University, Seattle).

*Water Research*, 1994, 28, No. 12, 2469-2476.

Duckweed, *Lemna minor*, was grown for 7 d in secondary-treated 0.45 µm filtered domestic wastewater to which total copper of 0.024-0.220 mg per litre had been added. Starch gel electrophoresis of plant extracts followed by enzyme staining showed that the activity of one of 4 isozymes, probably manganese-superoxide dismutase (Mn-SD), was inhibited when the plants contained 408 µg copper per g dry weight but not in plants with 215 µg copper per g dry weight or less. Measurements of SD activity in a reaction mixture, by inhibition of superoxide radical-dependent reaction, showed significant reduction in activity in extracts of plants with the higher copper levels but not in those with 215 µg copper per g. The isozymes in *Lemna* were tentatively identified by cyanide-sensitivity as copper, zinc-SD and Mn-SD. There are 31 references. U.S.A.

### 95-0976

**Effects of cadmium on limb regeneration in the northwestern salamander *Ambystoma gracile*.**

A. V. NEBEKER (U.S. EPA, Corvallis, Ore.), G. S. SCHUYTEMA, and S. L. OTT.

*Archives of Environmental Contamination and Toxicology*, 1994, 27, No. 3, 318-322.

Cadmium significantly affected limb regrowth in *Ambystoma gracile* larvae, the lowest observed adverse effect level being 193 µg per litre in a 24-d test and 44.6 µg per litre in a 10-d test. There were no significant adverse effects at 48.9 and 12.8 µg per litre in the 24 and 10-d tests, respectively. U.S.A.

### 95-0977

**Influence of protective agents in the toxicity of cadmium to a freshwater fish (*Channa punctatus*).**

K. V. SASTRY (M.D. University, Rohtak, Haryana), and V. SHUKLA.

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No. 5, 711-717.

The effects of cadmium (11.2 mg per litre) on the rate of oxygen uptake by the whole body and tissues (gill, muscle, liver, kidney) of the freshwater fish *Channa punctatus* were investigated. The influence of zinc (0.004 mg per litre), selenium (0.011 mg per litre), and

ascorbic acid (0.009 mg per g body weight) on the toxicity of cadmium was studied. One-tenth of these concentrations was used for chronic exposure studied. Oxygen uptake by the whole body and different tissues decreased following acute and chronic exposure to cadmium. Zinc was the most effective, followed by selenium, in reducing the toxicity of cadmium. The protective effect in the tissues decreased in the order gill, liver, muscle, kidney. Oxygen uptake decreased most in gills, followed by muscle, liver and kidney.

India

### 95-0978

**Sublethal concentrations of mercury in river otters: monitoring environmental contamination.**

R. S. HALBROOK (Georgia University, Athens), J. H. JENKINS, P. B. BUSH, and N. D. SEABOLT.

*Archives of Environmental Contamination and Toxicology*, 1994, 27, No. 3, 306-310.

Mean mercury concentrations in muscle and hair were greater in *Lutra canadensis* from the lower coastal plain of Georgia (4.42 and 24.25 mg per kg wet weight, respectively) compared to those from the piedmont (1.48 and 15.24 mg per kg, respectively). Liver mercury concentration (7.53 mg per kg) in lower coastal plain *L. canadensis* was not correlated with hair or muscle mercury concentrations. Mean foetus brain and muscle mercury concentrations were 1.03 and 1.58 mg per kg wet weight, respectively and foetal muscle mercury concentrations were correlated with maternal muscle mercury concentrations. Mercury concentrations in carnivorous fish were greater than those in omnivorous and insectivorous fish. There are 46 references. U.S.A.

### 95-0979

**Distribution of mercury in the soft tissues of the blue tilapia *Oreochromis aureus* (Steindachner) after acute exposure to mercury (II) chloride.**

P. ALLEN (National University of Singapore).

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No. 5, 675-683.

The distribution of mercury in liver, brain, gills, intestine, caudal muscle, spleen, kidney, testes, eye, bile and plasma in *Oreochromis aureus* exposed to 0.5 or 0.1 mg mercury per litre for 12 and 24 h and for 1 week was studied. There was an increase in mercury concentration with time for all tissues except brain. Kidney was the target organ for mercury during acute exposures (accumulating up to 208 µg per g after 1 week exposure to 0.1 mg per litre). The safety level for fish and fish products intended for human consumption is 0.5 µg per g wet weight. Singapore

### 95-0980

**Effects of mercury (II) species on cell suspension cultures of *Catharanthus roseus*.**

L. ZHU (Hangzhou University), and W. R. CULLEN.

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No. 5, 779-786.

The effects of mercury(II) species on the growth of the Madagascar Periwinkle (*Catharanthus roseus*) cultures at pH 5.5 were studied. The effects of selenate, selenite, chloride, L-cysteine in the media on the acute toxicity of mercuric oxide were determined. The effects of pH, chemical species and speciation of mercury(II) on toxicity were studied. The toxicity of mercury(II) species decreased in the order: methylmercuric chloride, mercuric chloride, mercuric acetate, mercuric oxide. Mercury content in the dry cells was proportional to that in the culture medium. The maximal bioconcentration factors of

mercuric oxide, mercuric acetate, mercuric chloride and methylmercuric chloride were 1760, 1840, 1702 and 2500 respectively. Addition of 0.1M chloride caused aggregation of cells. Addition of cysteine to the culture medium caused significant decreases in the toxicity of mercuric oxide to *C. roseus* cultures at pH 5.5. Toxicity of mercuric compounds to *C. roseus* decreased with increasing pH in the medium. In the presence of 0.1, 0.25 and 0.5 ppm selenite or selenate the toxicity of mercuric oxide to *C. roseus* was not reduced. **China**

#### 95-0981

**Effects of low water pH on lead toxicity to early life stages of the common carp (*Cyprinus carpio*).**

A. J. H. X. STOUTHART (Nijmegen University), F. A. T. SPANINGS, R. A. C. LOCK and S. E. WENDELAAR BONGA. *Aquatic Toxicology*, 1994, **30**, No 2, 137-151.

The incidence of spinal cord deformations, heart rate, body movements, hatching success and whole body concentration of potassium, sodium, magnesium, calcium and lead were assessed in *Cyprinus carpio* eggs exposed immediately after fertilization to 0.12-0.96 µmol lead per litre at pH 7.5 and 5.6. At pH 7.5, lead increased heart rate and decreased body movements. At pH 5.6, lead also reduced hatching success, caused spinal cord deformation, decreased net calcium uptake and increased larval mortality in a concentration dependent manner. Thus the toxicity of lead for *C. carpio* eggs was greatly enhanced at low pH. There are 33 references. **Netherlands**

#### 95-0982

**Lead poisoning in waterfowl from the Ebro delta, Spain: calculation of lead exposure thresholds for mallards.**

R. GUITART (Barcelona Autonomous University, Bellaterra), I. TO FIGUERAS, R. MATEO, A. BERTOLERO, S. CERRADELO and A. MARTINEZ VILA. *Archives of Environmental Contamination and Toxicology*, 1994, **27**, No 3, 289-293.

Sediment examination in the Ebro Delta National Park during 1991-92 showed that in some areas, lead shot concentrations available to waterfowl ranged between 60-149 and 544-748 shot pellets per ha. Of the 4 different species that had ingested lead shot, 50 ducks, mainly *Anas platyrhynchos*, were further investigated and the gizzard contents revealed that 25 per cent had ingested lead pellets. Using atomic absorption spectrometry, threshold values of lead in liver and kidneys after probit transformation of data were 1.5 and 3.0 µg per g wet weight, respectively. Results of lead concentrations and gizzard examination showed that 27 per cent of *A. platyrhynchos* in the winter period were poisoned. **Spain**

#### 95-0983

**Mercury in livers of wading birds (Ciconiiformes) in southern Florida.**

S. F. SUNDLOF (Florida University, Gainesville), M. G. SPALDING, J. D. WENTWORTH and C. K. STEIBEL. *Archives of Environmental Contamination and Toxicology*, 1994, **27**, No 3, 299-305.

There were significant differences in hepatic mercury concentrations in 7 species of wading birds collected from different geographic locations in southern Florida, in birds of different ages, dietary factors and relative amounts of body fat. There were significantly greater concentrations of hepatic mercury in birds from the central Everglades and eastern Florida Bay. Fledgeling and young adult birds had approximately 3 times the hepatic mercury concentration than nestling birds. Birds feeding on larger fish had approximately 4 times

the hepatic mercury concentration of birds feeding on smaller fish and crustaceans. Birds with minimal to moderate amounts of body fat had 2-3 times higher hepatic mercury concentrations than birds with relatively abundant body fat. Of the 144 birds examined, 31 per cent had hepatic mercury in excess of 2 µg per g and 7.6 per cent had concentrations greater than 12 µg per g. In birds of potential breeding age, 67 per cent had hepatic mercury concentrations above 2 µg per g and 24 per cent had concentrations above 12 µg per g. In the Everglades and eastern Florida Bay, 80 per cent of potential breeding age birds had hepatic mercury concentrations above 2 µg per g and 30 per cent above 12 µg per g. There are 32 references. **U.S.A.**

#### 95-0984

**Snail (*Helix aspersa*) exposure history and possible adaptation to lead as reflected in shell composition.**

M. C. NEWMAN (Georgia University, Aiken, S.C., U.S.A.), M. MULVEY, A. BIEBY, R. W. HURST and I. RICHMOND. *Archives of Environmental Contamination and Toxicology*, 1994, **27**, No 3, 346-351.

The relative intensity and duration of lead exposure in snails (*Helix aspersa*) populations from 33 sites in England and Wales are described using lead isotopic data. Snails from populations with long histories of exposure (millennia) to high lead levels had proportionately more lead in their shell than soft tissue. **U.K.**

#### 95-0985

**Mercury concentrations in marine species from the coastal area of Tarragona province, Spain. Dietary intake of mercury through fish and seafood consumption.**

M. SCHUMACHER (Rovira Virgili University, Reus), J. BATISTE, M. A. BOSQUE, J. L. DOMINGO and J. CORBELLÀ.

*Science of the Total Environment*, 1994, **156**, No 3, 269-273. The mean concentration of mercury in 592 samples of 21 marine species collected between November 1992 and February 1993 at 4 sites on the Tarragona coast, Spain, ranged between 1 and 1819 µg per kg wet weight. Species which accumulated the highest levels of mercury were *Pagellus erythrinus*, *Trisopterus minutus*, *Solea solea*, *Nephrops norvegicus* and *Squilla mantis* while the lowest mercury concentrations were observed in the mollusc group. In a subsequent study, the average dietary intake of mercury from fish and seafood by the population of Tarragona province was estimated to be 16 µg per d. **Spain**

#### 95-0986

**Distribution and effects of tributyltin chloride and its degradation products on the growth of the marine alga *Pylova lutheri* in continuous culture.**

R. SAINT-LOUIS (Université du Québec, Rimouski), J. PÉTIETIER, P. MARSOI and R. FOLNIER. *Water Research*, 1994, **28**, No 12, 2533-2544 (in French, English summary).

*Pylova lutheri*, cultured under chemostat conditions, was exposed to 18.5-74 and 185 nmol tributyltin chloride per litre. A batch culture was exposed to 13 nmol per litre for 48 h. Organotin species dissolved in the culture, adsorbed on the external walls and dissolved in the cellular fluid were monitored by gas chromatography. Adsorption onto the cell walls was directly related to nutrient tributyltin chloride concentration. Intracellular organotin levels decreased as level tributyltin chloride rose. The culture receiving 74 and 185 nmol tributyltin chloride per litre suffered severe toxic shock; most recovery from the higher concentration took place in 2-3 d. The organism



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was able to adapt to tributyltin chloride and convert it to the less toxic di- and monobutyl forms. This ability could offset the toxic effects on filter feeders of ingesting *P. lutheri* which had been exposed to tributyltin chloride. There are 49 references. (English translation 400 pounds sterling valid for 1995). **Canada**

95-0987

**Characterization of cytochrome P4501A induction in medaka (*Oryzias latipes*) by samples generated from the extraction and processing of coal.**

C. COHLIN (West Virginia University, Morgantown), A. STIEGLER and M. R. MILLER

*Archives of Environmental Contamination and Toxicology*, 1994, 27, No 3, 400-405

Ethoxycoumarin (*O*) deethylase (EROD) activity in *Oryzias latipes* livers was used to assess induction of cytochrome P4501A following the addition of beta naphthoflavone, various processed coal samples and petroleum pitch to aquaria water. Significant EROD induction was observed beginning at a concentration of 0.1 mg per litre; however a coal tar pitch significantly increased EROD activity at 0.01 mg per litre. Different samples induced EROD activity to different extents although there was always a concentration dependent increase. Western blot analysis showed that increased EROD activity was associated with relatively similar increases of immunoreactive cytochrome P4501A. EROD induction was not influenced by gender, single or multiple xenobiotic exposure nor by feeding or fasting animals during exposure. The compounds tested did not exhibit a strong correlation between P4501A induction and bacterial mutagenic activity. However P4501A induction in *O. latipes* liver could be a means of characterizing various materials or polluted water samples. There are 36 references. **U.S.A.**

95-0988

**Direct observation of herbicide action in algae using 10 ns resolved chlorophyll fluorescence induction kinetics.**

B. RUTH (Institute of Soil Ecology, Neukirchberg)

*Archiv für Hydrobiologie*, 1994, 131, No 3, 297-308

Terbutylazine of between 0 (control) and 200 µg per litre was applied to *Senedesmus quadricauda*, *Microcystis aeruginosa* and *Navicula pelliculosa* and the chlorophyll fluorescence induction kinetics, excited after a 15 minute dark adaptation, were measured with a maximal time resolution of 10 ns. The effects of the herbicide on the induction kinetics were detectable after 20 minutes with their greatest effect after about 3 h. At herbicide concentrations of 5 or 10 µg per litre, there was a significant progressive increase of the derivative B. An enhanced value of B was a direct measure of the herbicide action in the photosynthetic system. **Germany**

95-0989

**Organochlorine concentration dynamics in lake Michigan chinook salmon (*Oncorhynchus tshawytscha*)**

M. A. MILLER (Wisconsin Department of Natural Resources, Madison)

*Archives of Environmental Contamination and Toxicology*, 1994, 27, No 3, 367-374

Total concentrations of PCB in chinook salmon (*Oncorhynchus tshawytscha*) from Michigan lake decreased exponentially from the mid 1970s to mid 1980s, since then there had been an asymptotic trend. There were similar PCB concentration reduction trends in *Alosa pseudoharengus* and *Coregonus hoyi*. The total concentration of PCB in *O. tshawytscha* were positively correlated with fish length. Organochlorine (OC) concentrations in *O. tshawytscha* eggs were

positively correlated with concentrations in the muscle tissue of gravid fish. Egg and sac fry OC concentrations were also positively correlated. Estimated egg mass and quantity of OC in *O. tshawytscha* eggs showed that a significant proportion of somatic OC were eliminated through spawning. There are 43 references. **U.S.A.**

95-0990

**Organochlorine contaminants in common tern (*Sterna hirundo*) eggs and young from the river Rhine area (France).**

I. CASTILLON (Heredia National University, San Jose, Costa Rica), E. THYBAUD, T. CAQUET and F. RAMADE  
*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 5, 759-764

A study was conducted to determine whether intoxication of chlorinated compounds was responsible for reproductive failure in colonies of common terns (*Sterna hirundo*) on the Rhine river, France in 1988. Ten eggs and 10 dead young terns were analysed for organochlorine compounds using liquid liquid extraction and gas chromatography. DDE and PCB were detected in every egg and young tern. PCB levels were 100 to 1000-fold higher than those of DDE. Gamma HCH was detected in every dead tern and more than 65 per cent of the other samples. Heptachlor epoxide was detected in 40 per cent of eggs and 20 per cent of young terns. p,p' DDT, o,p' DDD, alpha endosulfan and dieldrin were not detected in any sample. DDE and PCB levels were significantly higher in yolks than in embryos. It was unlikely that organochlorine residues were the single factor responsible for the observed reproductive failure of common tern in the Rhine river area. **France**

95-0991

**Residues of chlorinated pesticides in the eggs of Karelian birds, 1989-90.**

N. MEDVEDEV (Karelian Scientific Centre) and I. MARKOVA  
*Environmental Pollution*, 1995, 87, No 1, 65-70

Eggs were collected from common gulls (*Larus canus*), herring gulls (*Larus argentatus*), black-headed gulls (*Larus ridibundus*), common terns (*Sterna hirundo*) and crows (*Corvus cornix*) in south Karelia. All contained DDE and lindane. Lindane concentrations showed significant differences between 2 groups of species, with high concentrations (0.019-0.022 ppm wet weight) in herring gulls, common gulls and common terns, which feed at sea, and lower ones (0.007 and 0.005 ppm) for black-headed gulls and crows, respectively, which feed partly or exclusively on land. The highest mean DDE concentration (0.204 ppm) was in eggs of herring gulls, and the lowest (0.07 and 0.04 ppm) for black-headed gulls and crows. There are 58 references. **Russia**

95-0992

**Effects of polyhalogenated aromatic hydrocarbons (PHAHs) on biochemical parameters in chicks of the common tern (*Sterna hirundo*)**

A. J. MURK (Agricultural University Wageningen), A. T. C. BOSVELD, M. van den BERG and A. BROUWER  
*Aquatic Toxicology*, 1994, 30, No 2, 91-115

*Sterna hirundo* eggs from 8 breeding colonies differing in the level of PHAH pollution were artificially incubated and chicks sacrificed 12 h after hatching. Yolk sac PHAH residues measured were polychlorinated biphenyl (PCB), polychlorinated dibenzofuran (PCDF) and polychlorinated dibenzo-p-dioxin (PCDD). No significant differences were observed between colony average levels of plasma thyroid hormones (total thyroxine, free thyroxine and triiodothyronine) nor plasma retinol levels and T4 glucuronyltransferase (T4

(GT) activities. However, average colony yolk sac retinyl ester levels did show significant differences. There were significant correlations between all parameters and PHAH levels or hepatic ethoxyresorufin and pentoxyresorufin-O deethylase (EROD and PROD) activities when correlated for individual *S. hirundo*. Another retinoid resembling 3,4-didehydro retinol (vitamin A2) in chromatographic and spectroscopic behaviour was also found which showed significant positive correlation with yolk sac dioxin equivalents and with hepatic EROD activity. Esters of both retinoids were detected in the yolk sac. Yolk sac vitamin A levels of the cleanest colony were significantly higher than the average levels in other colonies. Chicks requiring a longer period of incubation before hatching had significantly lower levels of yolk sac retinyl palmitate and higher PHAH levels. The ratio plasma retinol to yolk sac retinyl palmitate was significantly increased. There are 44 references. **Netherlands**

## 95-0993

**Relationship between polycyclic aromatic hydrocarbon (PAH) concentrations in bottom sediments and liver tissue of bream (*Abramis brama*) in Rybinsk reservoir, Russia**

R. SIDDALL (Derby University, U.K.), P. W. J. ROBOHAM, R. A. GILL, D. F. PAVLOV, and G. M. CHUIKO (*Chemosphere*, 1994, 29, No 7, 1467-1476)

In 1987 the Rybinsk reservoir, Russia, was contaminated by a spill of wastewater from a steel plant in Tcherepovets. Polycyclic aromatic hydrocarbon (PAH) levels were measured in reservoir sediment and liver tissue of bream (*Abramis Brama*) in 1990 by HPLC and fluorimetric detection. Sediments in Sheksninsky bay, adjacent to Tcherepovets were still heavily contaminated with PAH. Perylene and benzo[*b*]pyrene were the dominant PAH. Marked differences were observed in the distribution of high and low molecular weight PAH, possibly reflecting differences in sources of the 2 PAH groups. The source of high molecular weight PAH was thought to be waste waters from Tcherepovets. Low molecular weight PAH were thought to derive from atmospheric deposition. Differences were also shown in the distribution of low and high molecular weight PAH in bream liver tissue. Low molecular weight PAH were bioconcentrated in bream livers, particularly at sites adjacent to the steel plant wastewater outlet. **Russia**

## 95-0994

**Bioconcentration of polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans in guppies after aqueous exposure to a complex PCDD/PCDF mixture: relationship with molecular structure**

H. LOONEN (Amsterdam University), M. TONKES, J. R. PARSONS, and H. A. J. GOVERS (*Aquatic Toxicology*, 1994, 30, No 2, 153-169)

The accumulation data of 15 toxic dioxins and furans were quantified simultaneously in *Poecilia reticulata* exposed to a complex mixture of polychlorinated dibenzo-*p*-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) in water for 21 d. Uptake rate constants ranged from 217 to 1310 litres per kg d and first order elimination rate constants ranged from 0.0360 to 0.292 per d. The non laterally substituted congeners were either not observed in fish tissue or showed lower bioaccumulation factors (BCF) than their laterally 2,3,7,8-substituted isomers. The log bioaccumulation factors of laterally substituted congeners ranged from 3.90 plus or minus 0.06 to 5.27 plus or minus 0.07. The BCF values of these persistent TCDD and PCDF were lower than would be predicted from their high

hydrophobicity. Several processes that can contribute to the relatively low BCF values are discussed. There are 48 references. **Netherlands**

## 95-0995

**Comparative cytotoxicity of chlorophenols to cultured fish cells.**

H. SAITO (Mitsubishi Kasei Institute of Toxicological and Environmental Sciences, Yokohama) and T. SHIGEOKA (*Environmental Toxicology and Chemistry*, 1994, 13, No 10, 1649-1650)

Carp brain cells from *Cyprinus carpio* and fin cells from medaka *Oryzias latipes* were used to examine the cytotoxicity of phenol and its chlorinated derivatives using a neutral red (NR) incorporation assay. The results of these tests were compared with previous data from with identical experiments with goldfish *Carassius auratus* scale cells. Using 24 h NR50 values all 3 cell lines gave excellent correlation for chlorophenol cytotoxicity. **Japan**

## 95-0996

**Effect of three synthetic pyrethroids to a non-target fish, *Channa striatus***

A. SINGH (Gorakhpur University, India) and R. S. AGARWAL (*Acta Hydrochimica et Hydrobiologica*, 1994, 22, No 5, 237-240) (in English)

The possible consequences of the application of 3 synthetic pyrethroids (permethrin, cypermethrin and fenvalerate) capable of acting as powerful molluscicide for the control of diseases spread by liver flukes having snails as an intermediate host, were investigated with respect to the fish species *Channa striatus*. Doses of up to 80 per cent of the LC50 (24 h exposure) did not cause any significant change in the levels of total protein and free amino acids in the liver for exposure periods of less than 96 h. For exposure periods of 96 h and over, significant changes were apparent, probably due to disruption of the enzymatic pathways involved, but these were reversible and levels of protein and amino acids returned to normal 144 h after transfer to clean water. This reversibility would be beneficial in the case of direct application of these pesticides to streams where the host snails could proliferate, leading to endemic fascioliasis in cattle and other livestock in northern India. **India**

## 95-0997

**Acute toxicity and hazard assessment of Rodeo, X-77 Spreader, and Chem-Trol to aquatic invertebrates**

C. J. HENRY (South Dakota State University, Brookings), K. J. HIGGINS, and K. J. BUEHL (*Archives of Environmental Contamination and Toxicology*, 1994, 27, No 3, 392-399)

Mortality patterns of caged midge (*Chironomus* spp.) amphipod (*Hyalella azteca*), pond snail (*Stagnicola elodes*) and leech (*Nepheleopsis obscura*) in reference wetlands and those treated with a tank mixture of Rodeo, X-77 Spreader and Chem-Trol were similar after 21 d. In a laboratory study, X-77 Spreader (LC50 2.0-14.1 mg per litre) was about 83-136 times more toxic than Rodeo (LC50 218-1216 mg per litre) to aquatic invertebrates. Chem-Trol killed less than 10 per cent of animals at 10,000 mg per litre and less than 50 per cent of animals at 28,000 mg per litre. *Daphnia magna* were more sensitive than the other species to X-77 Spreader, Rodeo and simulated Rodeo tank mixes. The joint toxic action of the Rodeo tank mixture was additive for *H. azteca* and *Chironomus* spp. and greater than additive for *N. obscura*, whereas for *D. magna* it was less than additive. X-77 was the major toxic component of the mixture con-

## EFFECTS OF POLLUTION

tributing between 70 and 79 per cent of the summed toxic units. All binary combinations of X-77 Spreader, Rodeo and Chem-Trol at tank mix ratios were additive in toxicity to *H. azteca*. There are 36 references. U.S.A.

95-0998

**A cell proliferation assay for small fish and aquatic invertebrates using bath exposure to bromodeoxyuridine.**

M. J. MOORE (Woods Hole Oceanographic Institution, Mass.)

D. I. LEAVITT, A. M. SHUMATE, P. ALATALO, and J. J. STEGEMAN

*Aquatic Toxicology*, 1994, **30**, No 2, 183-188

*Oryzias latipes*, *Mya arenaria* and *Pseudodiaptomus coronatus* were exposed to waterborne bromodeoxyuridine (BrdU, 30 mg per litre) and fluorodeoxyuridine (FdU, 3 mg per litre), and uridine uptake from water was monitored using a simple spectrophotometric method. BrdU incorporation into nuclei of many organs was detected immunohistochemically. These organs were not limited to those directly exposed to the water in which the animal was held. The applications of this procedure are discussed. U.S.A.

95-0999

**Maternal transfer of chlordane and its metabolites to the eggs of a stream mayfly *Centroptilum triangulifer*.**

L. J. STANDLEEY (Academy of Natural Sciences Philadelphia

Avondale, Pa.), B. W. SWELLEY, and D. H. HUNK

*Environmental Science & Technology*, 1994, **28**, No 12, 2105

2111

Mayfly larvae (*Centroptilum triangulifer*) were reared to adults in 4-8 weeks in nutrient containing technical chlordane or algae which had been exposed to the chemical. Eggs produced by this group and hatched larvae were extracted by methylene chloride-methanol, cleaned up and analysed by gas chromatography-mass spectrometry. About 70 and 44-52 per cent of the chlordane and lipid loads respectively were transferred into the eggs. Lipid pools in adult tissues and eggs were not at equilibrium in terms of chlordane concentration. Eggs contained several times the levels of those in the mother's tissues but the chlordane fingerprints were similar. The effects were the same whether the chlordane originated from water or algae. The mayflies modified the technical chlordane so that the nonachlor component *trans*-nonachlor was dominant. Heptachlor epoxide and oxychlordane were also present such transformations were usual in mammals but anomalous for organisms at the mayfly trophic level. There are 33 references. U.S.A.

95-1000

**Hepatotoxic effects of hexachlorocyclohexane on carbohydrate metabolism of a freshwater fish *Channa punctatus* (Bloch).**

D. S. REDDY (Osmania University, Hyderabad, A.P.)

S. L. N. REDDY, and K. SHANKARIAH

*Bulletin of Environmental Contamination and Toxicology*, 1994,

**53**, No 5, 733-739

The effects of exposure for 15 d to a sublethal concentration (1.66 mg per litre) of the pesticide HCH (1,2,3,4,5,6-hexachlorocyclohexane) on the enzyme and metabolic profiles of carbohydrate metabolism in the liver of freshwater edible fish *Channa punctatus* were studied. The LC<sub>50</sub> of HCH was 5 mg per litre. The effects of HCH on glycogen, glucose, phosphorylase 'a' and 'ab', pyruvate, lactate, lactate dehydrogenase, glucose-6-phosphate dehydrogenase, succinate dehydrogenase and malate dehydrogenase levels in liver were investigated. Glycogen, glucose and pyruvate levels decreased dur-

ing HCH intoxication. Phosphorylase 'a' and 'ab' and glucose-6-phosphate dehydrogenase activities were increased. Activities of oxidative enzymes were increased. There was a shift from aerobic metabolism to anaerobic metabolism to combat the HCH toxicity. India.

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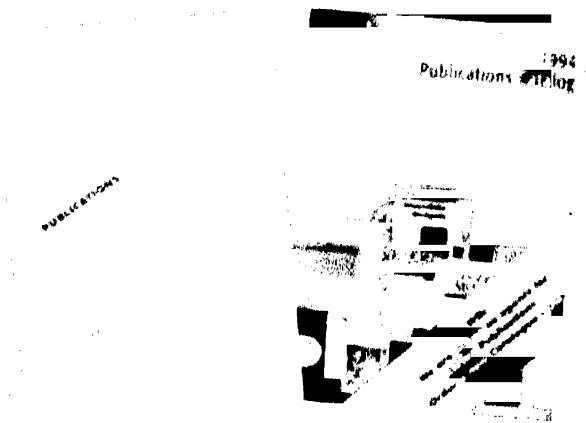


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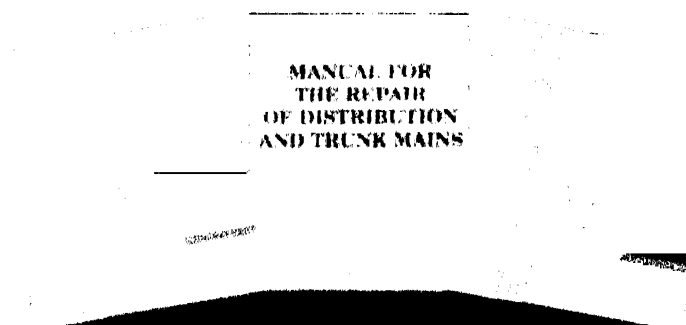


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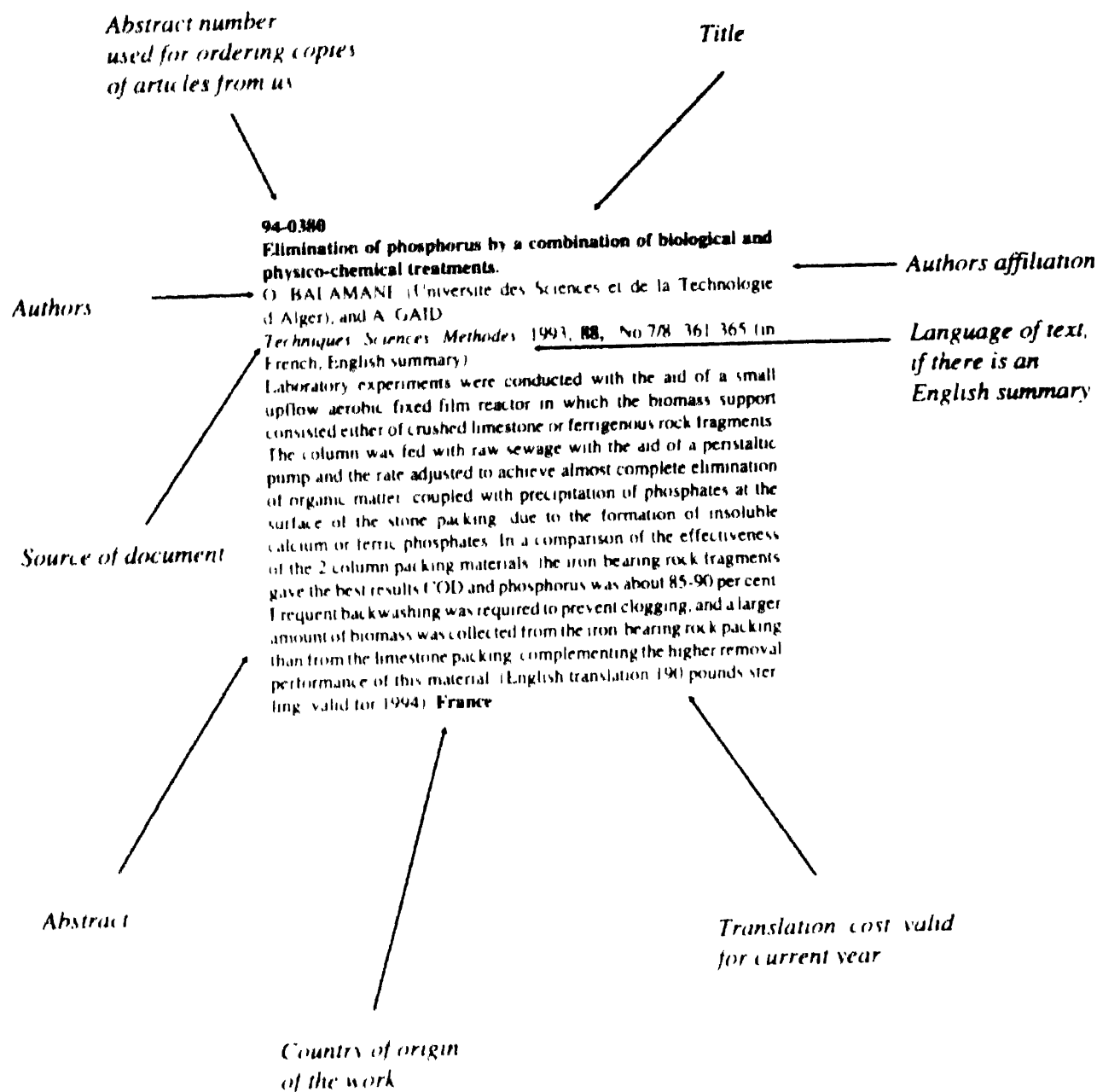
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## WATER RESOURCES AND SUPPLIES

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## 95-1001

**Clean Water Act reauthorization: how far have we come?**

A. M. FREEMAN (Bowdoin College, Brunswick, Me.)

*Water Resources Bulletin* 1994, 30, No 5, 793-798

The relationship between benefits and costs associated with the Clean Water Act of 1972 is examined. An earlier effort in 1979 to estimate the benefits associated with achieving Clean Water Act objectives is reviewed. Factors that would be involved in doing a retrospective benefit-cost analysis of the Clean Water Act and changes in measurements of water quality since the 1970s are discussed. A recent effort in 1994 to estimate the realized benefits associated with the Clean Water Act is summarized. The benefits were estimated using an explicit model of pollution discharges and changes in water quality. U.S.A.

## 95-1002

**Reauthorizing the Clean Water Act: looking to tangible values**

R. W. ADLER (Utah University, Salt Lake City)

*Water Resources Bulletin* 1994, 30, No 5, 799-807

The progress of the 1972 Clean Water Act is evaluated by reference to traditional measures of programme implementation (U.S. EPA's biennial National Water Quality Inventory, reductions in pollutants reaching surface waters, evaluation of long term trend data on ambient water quality) and to evidence of real world progress (human health risks, risks to aquatic species and ecosystems). This analysis indicated that the objective of eliminating the release of pollutants was a long way off. Serious point source releases continued but the majority of the remaining pollution came from urban and agricultural runoff. Progress had been made in curbing chemical pollution but significant habitat loss continued. Solutions to the problems could be divided into 4 categories: (1) filling gaps in standards, monitoring and information; (2) closing gaps in controls on point sources; (3) addressing polluted runoff (nonpoint source pollution); (4) protecting aquatic ecosystems. Economic versus multidisciplinary approaches to clean water are discussed with references to cost/benefit analysis of clean water programmes and cost effectiveness analysis of economic incentives. There are 52 references. U.S.A.

## 95-1003

**Prequalification procedures and quality assurance for underground pipe installation: consequences of European developments**

W. HEILMANN

*GWJ-Wasser/Abwasser* 1994, 135, No 11, 613-616 and 619-620

(German; English summary)

The implications of recent EC Directives in respect of competition and tendering for contracts on behalf of municipal and publicly owned corporations are discussed relative to the procedures already obtaining in West Germany. Under the new regulations pertaining to the single market for Europe, opportunities for tendering for contracts must be open to all contractors capable of complying with the relevant pre-qualifying conditions. The client is entitled to specify these conditions and the contractor must provide evidence of compliance. This procedure is compared with the existing provisions and specifications for pipelaying operations under the terms of the DVGW document GW 301, and the DVGW has been at pains to show

that its stipulations do not conflict with the new EC requirements (English translation 280 pounds sterling, valid for 1995).

Germany

## 95-1004

**Water in the war zone.**

J. PEARCE

*New Scientist* 1994, 144, No 1956, 13-14

The International Committee of the Red Cross (ICRC) had recently launched a campaign to improve the protection of water supplies and water engineers during war. At a symposium in Montreux, the ICRC had called for the bombing of waterworks to be outlawed and suggested similar protection for power stations. Problems faced in maintaining and repairing water supplies in war torn areas are discussed. International

## 95-1005

**Standard bearers.**

K. HAYWARD

*Water & Environment Management* 1994, No 21, 42-33

Progress to date by Northumbrian Water towards ensuring that its operational procedures will secure accreditation for their environmental consequences to the standard proposed by British Standard BS 57750 is outlined. The company worked on the premise that its water treatment and sewage treatment staff already knew their job and would not welcome additional form filling and report filing merely to confirm that all was well. But reporting when things were not well was entirely acceptable. Accordingly, additional training and demonstrations were provided to remind (where necessary) of long existing sources of potential environmental danger, such as storage of chemicals and the risk of spills, and to teach where such dangers had previously been unsuspected. A pilot scheme of reporting was initiated in the company's Northumberland area, involving the staff (often itinerant) of 2 water treatment works and 10 water pumping stations, and 100 sewage treatment works and 80 sewage pumping stations. A checklist of procedures and normal performance data was made available at each site, so that visiting staff, perhaps covering for regular staff who might be ill or on leave, would have basic point of departure data readily accessible. U.K.

## 95-1006

**Thoughts on the role, application and limits of standardization, based on activities in the water sector.**

H. ADAM (AI NOR)

*Techniques Sciences Methodes* 1994, 89, No 10, 546-549 (in French)

The large amount of effort being put into the task of standardization in respect of a wide range of products and services across the EC prompted a review of the progress achieved in the water sector approximately 4 years after the commencement of work in this area in 1990. The review particularly concerned the work of the Technical Committees TC 164 and TC 165 dealing with potable supplies and wastewaters respectively, within the framework of the European Standardization Committee together with a number of other committees, the subjects of which are related to the operation and control of water and sewerage networks and the materials quality aspects connected with them. The numbers of projects under each heading and the stages reached are tabulated, a total of 216 potential standards has currently been adopted by EC and nearly 1000 more are in various stages of preparation. A number of questions are raised concerning the practical utility of such a mass of documents which differ quite considerably in their size, content and mode of presen-

## WATER RESOURCES AND SUPPLIES

tation, and especially in their level of detail. Some suggestions are made which are aimed at simplifying and rationalizing the preparation of these standards, which are often widely criticized after publication. (English translation 180 pounds sterling valid for 1995). **Europe**

95-1007

**Effects of materials in contact with drinking water intended for human consumption. Influence of European standardization and prior research on national and European regulatory controls.**

J. L. GODET (Ministère des Affaires Sociales, de la Santé et de la Ville, AG/HTM), S. RIGAL and P. LEROY

*Techniques Sciences Méthodes* 1994, 89, No 10, 557-561 (in French-English summary)

A circular issued by the French Ministry of Health, dated 15th January 1994 introduced new guidelines applicable to materials in contact with drinking water: these officially recognized the results of prior testing of certain organic materials in respect of their inertness; in the not too distant future, the French regulations will be further amended and extended to include the effect of European standards in course of preparation. The new regulations will be concerned with organoleptic quality, chemical behaviour (based on migration tests) and microbiological properties (proliferation of bacteria in the water). The extension of these tests to all types of materials was at the stage preliminary to issue of EC standards. The implications of these pending standards on the establishment of a European system for approval and certification of materials for use in contact with drinking water are discussed, along with the nature of further definitive methods for approval of materials, including the use of standard methodology and the need for accurate specification of approved products and materials to be included in the so-called positive tests. The work of French government laboratories under the direction of the Higher Commission for Public Health is considered relevant to these questions. (English translation 165 pounds sterling valid for 1995). **France**

95-1008

**Sicily, inland-water management at the southern margin of Europe: call for an intersectoral dialogue**

P. ALCANTARA (Cantania University), R. DE PIETRO and R. GERICKI

*Ambio* 1994, 23, No 7, 455-457

Constructive debate between naturalists and investors was needed in the Mediterranean region. Sicily is used as an example of the lack of communication and information. Water demand had increased drastically. Deforestation caused decreasing groundwater levels. There were large scale infiltrations of seawater. Many artificial reservoirs were constructed for agricultural irrigation, drying the river beds below the dams. Effluents were channelized in cemented channels. Water pollution was an increasing problem. Italian environmental initiatives were often ineffective because of their reinterpretation by the local authorities. The Sicilian Piano Regionale di Risanamento dell'Acque illustrated this. A reevaluation of water requirements was needed and a strategy for economic exploitation of the water resources. **Italy**

95-1009

**Water management in Finland.**

T. S. KATKO (Tohtorinkatu, Tampere)

*European Water Pollution Control* 1994, 4, No 6, 40-46

The special features of Finnish water resources, water supply, sewerage, water pollution control and related legislation are described. The needs of water research, the limited applicability of economies of scale, regional cooperation and the institutional variety in water services are also considered. The wide differences in natural conditions dictated local, case by case, pollution control rather than rigid standards. Cooperation between the public and private sectors was preferred to privatization. More active public involvement by water and sewerage utilities was thought desirable. An integrated approach to water resources and water pollution control was considered essential to overall environmental protection and management. The policies should also apply to Finland's relations with its neighbours. **Finland**

95-1010

**Drinking water publicity with respect of Karlsruhe**

J. ULMER (Stadtwerke Karlsruhe)

*GW: Wasser/Abwasser* 1994, 135, No 11, 629-631 (in German-English summary)

The public relations activities of the Karlsruhe Public Works Department, responsible for drinking water supply to Karlsruhe and the surrounding district, are reviewed. The undertaking had deliberately maintained a high public profile, with regular appearances in the local media. The numerous additional activities designed to publicise the high quality of the local drinking water included exhibitions, a customer information centre in the heart of the city, the provision of guided tours for groups of citizens, organization of painting competitions and vacation play opportunities for children, and the maintenance of a mobile display vehicle, which was supplied with bottles of Sparkling Karlsruhe water, containing mains water to which a little carbon dioxide had been added, prior to bottling in a small filling machine at the local waterworks. A special feature for 1995 will be, in Open Day at the waterworks when visitors will be invited to observe the operation of a modern, fully automatic water quality monitoring station. Further developments planned for next year include the use of a large TV screen in the Customer Information Centre to display the results of analyses via a direct cable link with the waterworks laboratory. (English translation 100 pounds sterling valid for 1995). **Germany**

95-1011

**DUFLOW, case studies of an instrument for integrated water management.**

R. MEYER and den BOOMEN (Witteveen & Bos Raadgevend ingenieurs bv) and A. P. SALVERDA

*Hydro* 1994, 27, No 23, 689-691 (in Dutch-English summary)

The incorporation of additional features into the original DUFLOW model, which was intended as a one-dimensional dynamic modelling technique for open channels, is described. A recent (1992) addition was a water quality assessment feature. By using the model in a branch and node manner, flow and quality in a sewer system can also be considered in an integrated manner, and the probable effects of improvements at works on conditions at spot locations could be predicted. Desirable additional features would be facilities to incorporate the effects of rainfall on flow, and to superimpose the predictions on data stored in a geographical information system. (English translation 150 pounds sterling valid for 1995). **Netherlands**

95-1012

**Groundwater management for the central Netherlands: a new water balance.**

T. G. J. WITJES (Witteveen & Bos) and T. J. van de NES  
*H2O* 1994 27, No 25: 752-757 (in Dutch-English summary)

The initiation of a collaborative research programme on groundwater management between the 4 central Dutch provincial governments (Flevoland, Noord-Holland, Utrecht and Gelderland) and water companies within their area is described. All were faced with rising water demand, and were legally required to take measures to redress the drying out of traditionally wet areas. Alternative management strategies are to be prepared, to take account of the needs of the environment, public health and water suppliers, and to consider also the costs. All the scenarios were based on a new hydrological model of the aquifer underlying the entire region, and made assumptions as to the amount of surface water that might be used instead of ground water in future years. (English translation 300 pounds sterling valid till 1995) **Netherlands**

95-1013

**Environmental management in Yap, Caroline Islands: can the dream be realized?**

B. GOLDMAN (Marine Resources Management Division  
 Colonia)

*Marine Pollution Bulletin* 1994 29, No 1/3: 42-51

The difficulties of managing the environment and natural resources with small fragmented populations are examined for the state of Yap, where waters were almost unpolluted except for some contamination of Colonia harbour. Problems included poor education, a top-heavy executive and legislature combined with the power of veto at local level; this system lacked the flexibility to respond to rapid changes. Offshore fisheries, aquaculture, agriculture and tourism would be developed to broaden the economic base. A marine resources and coastal management plan had recently been completed. It identified environmental management issues, the responsible government agencies, and indicated manpower, training and legislative needs. Though foreign aid was required it needed more careful allocation. There are 47 references. **Micronesia**

95-1014

**Yap State Trochus Marketing Authority: a novel approach to financial management of living natural resources**

B. GOLDMAN (Yap State Government, Colonia)

*Marine Pollution Bulletin* 1994 29, No 1/3: 99-105

The creation of a Trochus Marketing Authority was likely to be approved by the Yap Legislature. Its functions would be the total management of the fishery, the marketing of the trochus internationally, and the covering of its costs from sales. This would enable resource management to be closely linked with the rent generated. It would address the problems of over-fishing, fragmented marketing, dependency on government funds for resource management, and the funding of research. Some day-to-day management difficulties would remain, exacerbated by lack of training and education. **Micronesia**

95-1015

**Implementation of GIS for water resources planning and management.**

M. R. LEIPNIK (U.S. Bureau of Reclamation, Boulder City, Nev.), K. K. KEMP, and H. A. LOARICA

*Water Resources Journal* 1994 No 180: 1-14

Stages in the implementation of geographical information systems (GIS) for water resources planning and management were examined. These included feasibility studies, selection of software, hardware and peripherals, system installation, training, data conversion, data base development and preliminary product generation. A generalized flow chart of the GIS implementation process was developed. Considerations related to each stage of implementation are discussed. Many related to critical choices with major cost implications. An appendix listing GIS and related software and indicating the analysis functions provided by each system is included. There are 38 references. **USA**

95-1016

**Steady growth for German water equipment industry**

J. ACZIL

*Water Science* 1994 No 19: 14-16

Exports of water treatment equipment by Germany were improving both within the EU and Eastern Europe, and also to Asia and the USA. There was a decline in imports of water equipment and accessories. However, Germany's economic situation was expected to improve at the end of 1994 and the beginning of 1995 and imports could increase by about 5 per cent over the next 12-18 months. **Germany**

95-1017

**Watershed-management: changes in animal population structure, income, and cattle migration, Shiwaliks, India**

S. L. ARYA (Central Soil and Water Conservation Research and Training Institute, Chandigarh), Y. AGSHTORI, and J. S. SAMRA

*Amha* 1994 24, No 7: 446-450

A watershed management programme initiated in 1984 in the Shiwalik foothill region comprised dam construction, an underground water conveyance system for irrigation, soil and water conservation measures, improved agrotechniques and the formation of a Hill Resource Management Society. The effects of the programme on the composition of cattle population, cattle migration, feed availability and fodder production were studied in Bunga village. The impact of cattle migration on village economy was also assessed. Closure of grazing areas enabled a slow regeneration of the hills. Supplemental irrigation almost doubled crop intensity. The availability of fodder increased. Animal husbandry contributed 54 per cent of the village's income. The number of goats decreased but the numbers of buffaloes, cows and bullocks increased. Despite improved fodder availability, this was not sufficient to feed the extra buffaloes and cows so migration of cows still occurred. **India**

95-1018

**Is tap water drinkable? Drinking water quality according to the media**

K. MERTIN

*GW/ Wasser/Abwasser* 1994 135, No 11: 621-628 (in German-English summary)

The problems for drinking water suppliers arising from hostile publicity in the media are discussed. In present day society public attitudes are conditioned by the information disseminated via a wide



## WATER RESOURCES AND SUPPLIES

range of methods, but especially newspapers and television. The manipulation of these media by pressure groups can give rise to distorted impressions of reality and to the creation of a public image for certain commodities, such as drinking water, which differs alarmingly from the generally accepted standards of a modern society. The question of the real state of affairs and the manner in which it can be determined are discussed on the basis of the thesis that reality is a combination of facts and relevant. To present a true picture of the state of drinking water quality, the relevance of unpleasant facts with respect to the everyday situation must be considered. Thus the technical and engineering efforts by water undertakers to guarantee a wholesome supply must be backed up by a sustained public relations effort designed to dispel the illusions generated by the hyped-up publicising of certain unfortunate aberrations. The general public must be convinced that its drinking water is wholesome despite persistent allegations to the contrary. (English translation 325 pounds sterling, valid for 1995) **Europe**

**95-1019**

### **Project management and control.**

R. REMINGTON (Thames Water International) and P. HEMMINGS

*Proceedings of Institution of Civil Engineers*, 1994, **102**, Special Issue 2, 9-13

Changes in the organization of Thames Water and the introduction of project management into the engineering function within Thames Water are overviewed. Since the start of the Thames Water Ring Main (TWRM) project, Thames Water had developed from a public utility to an international privatized company with a significantly increased capital expenditure programme. The TWRM project had also spurred a complete change in project monitoring, control and management. The use of project management tools such as TRACK, STAR is described. Together with associated procedures and computer systems, these now formed part of a BS5750 accredited system. The successful implementation of project management had contributed to the completion of the TWRM 2 years ahead of programme. **U.K.**

**95-1020**

### **Floodplain management.**

P. W. SOLTYS (Water Resources, Cincinnati, Ohio)

*Public Works*, 1994, **125**, No 11, 51-53

The Federal Emergency Management Agency (FEMA) was responsible for implementing and enforcing the provisions of the National Flood Insurance Programme (NFIP). Flood insurance maps and reports that had been published by FEMA to provide guidance to the local community in its floodplain management efforts are described. The 100-year flood was the base flood adopted by FEMA for floodplain management. Flood insurance zone designations for riverine studies are summarized. The floodway concept is outlined and its determination discussed. Reporting for floodplain management and floodproofing is outlined. Experiences of an Ohio power company's electrical substation in floodproofing are discussed. **U.S.A.**

**95-1021**

### **Fortifying the Oporto link.**

B. DUMBLETON

*Water Bulletin*, 1994, No 630, 10-12

Guidance is offered to British water engineers, consultants and components' suppliers as to how they might improve their chances of doing business in Portugal. Its Government has already decided

to introduce a form of privatization into the supply side of the business, the sewage side will, at least for the time being, be left to the discretion of municipal authorities, who may, if they wish, put it out to private contract for the duration of a concession, but who will re-possess the hardware at the end of it. For water supply, the design-build-operate practice is likely to be adopted. Although French companies, well-known internationally for their experience in this form of working, will have a long head-start over competitors from other nations, the door is not closed to U.K. businessmen, and several U.K. water companies, consultants and suppliers have already made approaches to potential Portuguese partners. **Portugal**

**95-1022**

### **Highway to heaven?**

A. TURNER

*Water Bulletin*, 1994, No 630, 15-16

The background to the decision by the Department of Transport in late-1994 to fund the creation of a national register of street-works is described. The present paper based arrangements, whereby any one utility needing to dig up a street informs the highway authority, but neither party is under any obligation to inform any other utility interested in such works, has led to excessive street works events. The computerized register, to be set up and operational, at least in part, by 1996, will act as a source of plans by all utilities, and should open the way to integrated use of a trench by any utility interested in planned maintenance of its buried assets. The costs of the register will initially be shared between the highway authority and utilities using it; other uses, such as the enhancement of a national street gazetteer, may introduce other sources of financial support. The register will become available in stages, their location reflecting earlier work in experimental areas since the mid 1980's by the National Joint Utilities Group. The first is likely to cover the West Midlands, building on the Dudley Digital Records trial which began in 1982, and will take input from several local highway authorities and water companies. **U.K.**

**95-1023**

### **When in Rome...**

M. HADDON

*Water Bulletin*, 1994, No 631, 10-11

Ideas on how British consultants and companies might become profitably involved in the forthcoming re-organization of the Italian water industry are advanced by the Anglo-Italian Water Initiative, a group founded by a British consultant engineer. The Galli Law, passed by the Italian Parliament but yet to be implemented, will reduce the present 8000 municipal supply authorities to 120, and proposes to invest 30 000 million pounds sterling in the next decade to upgrade the present water and sewage services. Only limited scope is seen for overseas capital investment or contractual work, as indigenous wealth and work force engineering skills are regarded as adequate, and more likely to be politically acceptable. A potentially better approach for a non-Italian organization is thought to lie in a partnership with an Italian equivalent, experienced in the ways of Italian political and business methods. British experience in coping with supply areas of the size of the new Italian ones should be valuable, as should its regulatory experience. No-one yet knows how the Italian man-in-the-street will react to the prospect of higher bills, the regional frameworks are not required by the Law to be the same - indeed, their very boundaries have not all yet been defined - and their capital programmes could vary widely in cost, equipment, and timing. **Italy**

95-1024

**When a city buys a utility.**

T. A. CLOUD (Gray, Harris, Robinson, Kirschenbaum & Peoples Orlando)

*Water Engineering & Management*, 1994, 141, No 10, 24-26

Reasons for municipalities to buy a utility for providing water and/or wastewater systems are examined. Factors to be considered in the acquisition of a utility are outlined. Issues faced by municipalities in Florida state in the acquisition of water and wastewater utilities are discussed. In response to this market, legislation was adopted by the state requiring detailed checks for the potential buyer. Differences between private and municipal ownership are explained. Various approaches to utility acquisition are discussed. U.S.A.

95-1025

**Application of GIS for maintenance in widespread distribution networks.**

D. J. GLASBROOK (Wessex Water Services Ltd, Poole)

*Water Supply*, 1994, 12, No 3/4, 119-138

The experience of Wessex Water in applying geographical information systems (GIS) to water supply networks are described. A brief history and current status of GIS in the U.K. is given. In Wessex Water the following were in the system: Ordnance Survey background data, 100 per cent of the water supply network and 30 per cent of the sewerage system, boundaries and zones, addresses of customers with special needs, postcode sector boundaries, and population data. The system, operating with a central processor and workstations employed 18 staff. A key development was a separate personal computerized mapping package called Aquamap which provided most of the facilities usually required without having to access the asset database. The data were updated weekly from the principal GIS. The GIS was used for planning rehabilitation, consumer complaint analysis, water quality, burst statistics and zone boundaries. Among the advantages of GIS were record maintenance, collation of data, output flexibility and spatial analysis. Further developments were anticipated. U.K.

95-1026

**Management of a widespread multi-plant water supply system.**

J. D. SNOXELL (Wessex Water plc, Bristol)

*Water Supply*, 1994, 12, No 3/4, 309-321

The management of Wessex Water's potable water distribution network serving 1.1 million consumers is described. Water production was managed as one integrated unit through extensive use of supervisory control, automation and data acquisition systems. Pumping plant was controlled by local automatic control loops with operation monitored continuously by the central telemetry computer. Data were captured centrally and made available through an archive to a personal computer network. Energy efficiency, improved treatment control, quality management systems, and optimization of network operation all resulted from the control philosophy. Key aspects of the systems are outlined. U.K.

95-1027

**Redesign of central control systems to meet emergency conditions.**

W. J. BISHOP (Contra Costa Water District, Concord, Calif.) and E. W. CUMMINGS

*Water Supply*, 1994, 12, No 3/4, 337-347

The utilization of central control systems in response to emergencies, and the improvement of performance by re-design, are discussed with reference to 2 Californian water utilities which had experienced

major disasters. Background data are provided for the utilities and their control systems are described. Their performances in the face of earthquake, unusually cold weather and a firestorm are evaluated. Improvements to central control systems, strengthening of facilities, central control remote back-up, the need for redundant communications, and the installation of alternative power supplies are examined. Extra remote sensing, decision support, emergency coordination and emergency planning support are also considered. U.S.A.

95-1028

**The rationality factor: choosing water sources according to water uses.**

A. ALMEDOM (London School of Hygiene and Tropical Medicine, U.K.), and C. ODHIAMBO

*Waterlines*, 1994, 13, No 2, 28-31

Some of the key findings from the first field trials on factors influencing the choice of water source by Kenyan villagers are reported. The study was conducted in Siaya district in western Kenya with the aim of investigating hygiene behaviour and activities and improving the health of the local people. The methods, technologies and tools used for the study are described. Water use patterns are discussed together with design and cost issues involved in protecting water sources. Kenya

95-1029

**Protect to survive: the case for rigorous environmental resource management.**

M. E. INCI (Loughborough University of Technology, U.K.)

*Waterlines*, 1994, 13, No 2, 2-4

The impact of human activities on environmental resources management, particularly the management of water resources, is addressed. Planning and management of water and of wastewater disposal in both rural and urban communities required practical knowledge of the quality and quantity of the resources in any given region and/or country, and the ways in which these were changing. Issues to be considered in raising awareness of the links between environmental damage and human activities and in balancing environmental planning with resource development are examined. International

95-1030

**Sanitation in Colombia's low-income settlements: selection, implementation, and evaluation.**

F. RESTROPOLARQUINO (Centro Inter-regional

Abastecimiento y Remocion de Agua, Cali) and M. E. INCI

*Waterlines*, 1994, 13, No 2, 25-27

The introduction and implementation of the Learning Process Projects on Water Supply and Sanitation programme in the city of Cali, Colombia, is described. The programme's objective was to research, develop and transfer methodologies and technologies for sanitation from low-income settlements in Aguablanca district to Cali, based on local and regional institution participation. Criteria for selecting technologies are summarized. Factors to be considered in their implementation are outlined and concepts used to evaluate their effectiveness are discussed. Issues influencing the success of this programme are addressed. Colombia

95-1031

**Industry loses pounds with special K diet.**

S. HOARE

*Construction News*, 1994, No 6392, 18-19

The impact on contractors of the cuts in K factors imposed by C/wat on the water companies in their 5 year review is examined. Although

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the K factors were originally intended to safeguard water industry investment following privatization, the cuts were imposed to redress the water companies' windfall profits made by keeping their prices at the permitted levels while benefiting from falling construction costs. Objections of the water companies to Ofwat's review are discussed. U.K.

### 95-1032

**Procurement strategy and contract management philosophy.**  
P. NASH (Thames Water Utilities Ltd), R. MCGILL, and J. OKAFIAGHAN

*Proceedings of Institution of Civil Engineers*, 1994, **102**, Special Issue 2, 76-82

There had been significant changes and developments in procurement strategy and contract management philosophy during the 8 year construction period of the Thames Water Ring Main (TWRM). These developments are described. Factors influencing these changes are discussed. The concept of positive cost control as developed for the project is considered. Tender documentation and assessment are discussed together with financial management. The views of a contractor involved with both phases of the project are also given. U.K.

### 95-1033

**The importance of process in economic regulation.**  
I. BYATT

*Resources*, 1994, **3**, No 1, 7-10

The approach adopted by the Director General of Water Services to the execution of his task is set out. Paramount considerations are consultation with all parties concerned, responsiveness to their points of view, and open publication of decisions taken. Those consulted include government ministers, the water services companies themselves, inspectorates, the pressure groups, and the consumer. All must both provide and receive adequate information for the decisions to be arrived at, and not feel that those decisions have been made from an *a priori* standpoint. The interim positions adopted when such matters as the cost of quality, or the means of paying for water, were under discussion, how they were reached, and how they evolved into formal positions are considered, as are the implications of the strategic business plans put forward by the companies influencing the determination of their K factors. The methodology of discussion, via meetings with interested parties, the publication of position papers, the formation of working groups, appearances before Commons and Lords Select Committees, interviews on radio and television, and the preparation of videos, is fully described. U.K.

### 95-1034

**Water holding companies in England and Wales.**

M. H. WELLS (Construction Forecasting & Research Ltd, London)  
*Water Sources*, 1994, No 20, 14-16

Growth of the water companies in the years following privatization is examined. The water companies of England and Wales are listed. The turnover and pre-tax profits of the water holding companies and their water services companies for the years 1992-93 and 1993-94 are summarized. The non-regulated sales of these companies, covering a range of activities, are examined. The future potential of the water companies as international leaders in the world market is discussed. U.K.

### 95-1035

**Spatial disaggregation for studies of climatic hydrologic sensitivity.**

D. EPSTEIN (Pacific Northwest Laboratory, Richland, Wash.), and J. A. RAMIREZ

*Journal of Hydraulic Engineering*, 1994, **120**, No 12, 1449-1467

Empirical disaggregation techniques were applied directly to temperature and precipitation data to resolve output from general circulation models (GCM) to regional and local climate regimes. Raw GCM output could not be used as forcing in the smaller-scale hydrological models because of incongruities in model resolutions. The response of the upper Rio Grande basin to climate-change forcing was explored by applying the resulting localized climate to the Precipitation Runoff Modelling System of the U.S. Geological Survey. A 2-level disaggregation scheme was used. Seasonal shifts in peak runoff, soil moisture storage and evapotranspiration to earlier in the year were predicted when a doubling of carbon dioxide was assumed. U.S.A.

### 95-1036

**The sensitivity of northern Sierra Nevada streamflow to climate change.**

L. L. W. DUELL (U.S. Geological Survey, San Diego, Calif.)  
*Water Resources Bulletin*, 1994, **30**, No 5, 841-859

The sensitivity of streamflow to climate change was investigated in the American, Carson and Truckee river basins in California and Nevada, U.S.A. Climate data for 1942-1991 were used. Annual multiple regression models were developed by regressing streamflow data for 1961-1991 on temperature and precipitation. Nine gauging stations were used to represent streamflow for different basin elevations and areas. Model variables included monthly mean temperatures or the annual mean temperature, and annual total precipitation. Stepwise regression showed precipitation to be the most significant variable, explaining 80 per cent of the variation in streamflow. Model calibration and verification procedures are described. Model responses to climate change were examined using historical climate data and modifying mean temperature and total precipitation. Streamflow on the warmer, lower west side of the Sierra Nevada was more sensitive to temperature and precipitation changes than that on the east side. U.S.A.

### 95-1037

**Spatially averaged conservation equations for inter-rill-interrill area overland flows.**

G. LAYFUR (California University, Davis), and M. I. KAVVAS  
*Journal of Hydraulic Engineering*, 1994, **120**, No 12, 1426-1448

A model of overland flows which combined rill flow dynamics with inter-rill area sheet flow dynamics at hillslope scale was developed. The objective was to treat the flows at inter-rill areas in 2 dimensions with no limitations on the natural variability of the surface micro-topography. An adequate model should account for the interaction occurring between the flows in rills and sheet flows over inter-rill areas. It was assumed for modelling purposes that a flux existed from inter-rill sections toward the rills. Results were in good agreement with field observations. The effects of average local slopes and rill occurrence probability on flow rates were quite pronounced. U.S.A.

95-1038

**Three-dimensional analysis of infiltration from the disc infiltrometer. 1. A capillary-based theory.**K. R. J. SMETTEM (Western Australia University, Nedlands), J. Y. PARLANGE, P. J. ROSS, and R. HAVERKAMP  
*Water Resources Research*, 1994, **30**, No 11, 2925-2929

The use of the disc or tension infiltrometer to obtain *in situ* measurements of hydraulic properties of soil surface horizons is considered. Methods of analysis for the disc infiltrometer had generally relied on the restrictive assumptions of one-dimensional flow at early times or quasi-steady-flow at large times. An approximate analytical expression was developed for 3-dimensional unsteady unconfined flow out of a disc infiltrometer, including the geometric effect of the circular source but ignoring gravity. This solution was tested against laboratory data. The results showed that the difference between 3-dimensional and one-dimensional was linear with time. (See also following abstract) **Australia**

95-1039

**Three-dimensional analysis of infiltration from the disc infiltrometer. 2. Physically based infiltration equation.**

R. HAVERKAMP (Laboratoire d'Etude de Transferts en Hydrologie et Environnement, Grenoble, France), P. J. ROSS, K. R. J. SMETTEM, and J. Y. PARLANGE

*Water Resources Research*, 1994, **30**, No 11, 2931-2935  
The theory developed in the companion paper for the analysis of 3-dimensional unsteady unconfined flow from a disc infiltrometer was extended to derive a physically based equation for infiltration from an infiltrometer which would be valid for all times, and would account for corrections of the proportionality constant. A simplified infiltration equation was also developed for practical use. The full and simplified equations yielded results in close agreement with published experimental data and were particularly useful for determining soil hydraulic properties through the application of inverse procedures. (See also preceding abstract) **Australia**

95-1040

**Kernel quantile function estimator for flood frequency analysis.**Y. T. MOON (Utah State University, Logan) and U. T. ALI  
*Water Resources Research*, 1994, **30**, No 11, 3095-3103

The estimation of the flood quantile relationship using data from a gauged site was investigated. Two types of estimation method, the use of kernel quantile estimators based on the full sample and methods which focused on the tail of the distribution and attempted to develop estimators of right tail quantiles, are considered. A kernel estimator of the quantile function in which boundary kernels were used for the extrapolation of tail quantiles was developed. The band width of the estimator was chosen using an automatic method. Confidence intervals for the estimated quantile were derived by bootstrapping. The proposed estimator was competitive with other estimators. There are 44 references. **U.S.A.**

95-1041

**Defining and using reference evapotranspiration.**G. H. HARGREAVES (Utah State University, Logan, U.S.A.)  
*Journal of Irrigation and Drainage Engineering*, 1994, **120**, No 6, 632-639

Reference evapotranspiration (ETO) was computed from 3 sets of good quality lysimeter and climate data from comparable French sites using 3 versions of the Penman combination equation and the Hargreaves method that was based on a simple empirical equation

and required only measured maximal and minimal temperatures. Mean percentages of 10 d ETO in percent of evapotranspiration (ET) were 100, 96, 101 and 97 for the Penman classic, Penman calibrated, Penman Monteith and Hargreaves methods, respectively. Some seasonal variation in predicted 10 d percentages of ET was observed. Comparison of results obtained for data from sites in Europe, U.S.A. and Australia indicated that a Penman combination equation should be used as reference to calibrate other ETO estimation methods and that adjustment of equations to a common reference by regression through the centre was justified. ETO calculations should be standardized using perennial rye grass or Alfa fescue grass as standard reference crop. Data quality was extremely important and site conditions and crop coefficients should be standardized. The Hargreaves equation was recommended for general use. **International**

95-1042

**Modelling infiltration for multi-storm runoff events.**

R. E. SMITH (U.S. Department of Agriculture, Fort Collins, Colorado), C. CORRADINI, and E. MELONI

*Water Resources Journal*, 1994, No 180, 28-40  
Rainfall infiltration during complex storms was simulated using a simple analytical/conceptual model. The physically based model was capable of describing intervals of low rain, no rain or evaporation. The 3 parameter analytical infiltration model of Parlange et al. was extended to deal with soils with very high initial water content. The redistribution component of the model was based on profile extension with shape similarity. Model results compared favourably with numerical solutions of Richards' equation for a variety of events on 4 selected soils. Provided soil retention relations were parametrically represented. There are 34 references. **U.S.A.**

95-1043

**Numerical study of coastal changes.**

K. MIZUMURA (Kanazawa Institute of Technology, Nonoichi-machi)

*Advances in Engineering Software*, 1994, **19**, No 2, 85-89  
Two dimensional changes of a beach profile were computed by the continuity equation of the sediment. The wave transformation used in the continuity equation was obtained by solving the shallow water equations numerically. The approach was shown to be reasonable by its application for different wave height, period and sand particle diameters. Using field observations and the method of Nakamura beach demonstrated that it was bar shaped and stable without any protection. The theory of the method is explained. **Japan**

95-1044

**The Venice project: a challenge for modern engineering.**F. BANDARIN (University Institute of Architecture, Venice)  
*Civil Engineering*, 1994, **102**, No 4, 163-174

In 1984, a 2 billion pounds sterling civil engineering scheme was initiated by the Italian government to safeguard Venice from subsidence, rising sea levels and erosion. The scheme involved installation of mobile barriers across the lagoon inlets, reinforcement of coastal defences and jetties and reconstruction of the lagoon wetlands. The projects were aimed at defending the city and other lagoon settlements against the risks of flooding and at reversing environmental degradation. An overview is given of the various projects in the scheme and of the proposed engineering solutions. **Italy**

95-1045

## **Tidal current amphidromic system in semi-enclosed basins.**

X. ZONGWAN (State Oceanic Administration (Guangzhou), N. CARBAJAL, and J. SUDERMANN

*Continental Shelf Research*, 1995, 15, No 2/3, 219-240

The behaviour of tidal currents in semi-enclosed basins was examined in relation to the Taylor model of perfect Kelvin wave reflection in uniform-depth basins. This model explained the mechanism of an amphidromic system. It was shown in the case of the North sea that in a large semi-enclosed basin, current and nodal or amphidromic points for a tidal constituent would normally be found. The current amphidromic points were grouped according to their structure as middle and end points. The amphidromic systems for current and sea surface elevation were closely connected. This was shown in detail in the case of the North sea tidal current amphidromic system. **China**

95-1046

## **Rapid evolution of the tide in the Bay of Fundy.**

G. GODIN

*Continental Shelf Research*, 1995, 15, No 2/3, 369-372

Digitizing available water level data for Saint John, New Brunswick provided a broader data base for the analysis of the tide in the Bay of Fundy. Annual samples for the major components of the tide then covered the interval 1932 to 1980. The broader spread of data confirmed the trends in the local tide deduced earlier on the basis of a more restricted sample. The changes documented were in harmony with the rapid changes which appeared to have prevailed in the tides of the Bay of Fundy and in those of all coastal seas since the end of the last glaciation. The changes were associated with the inferred rise in sea in this intervening period. **Canada**

95-1047

## **Tide turns for coastal management.**

R. DIMENT (Sir William Halcrow and Partners Ltd.) and R. DE AKIN

*Surveyor*, 1994, 181, No 5316, 25-28

The application of a geographical information system (GIS) to coastal management data is described. GIS was used to develop classifications which resolved the shoreline into management units based on physical processes. Appropriate management policies could then be adopted according to the character of individual units. A process of ongoing monitoring and review is also needed to ensure the validity of the GIS. The implementation of a GIS within a responsive management framework is discussed. Data collection by the operating authorities is also considered. **U.K.**

95-1048

## **Introduction to a suite of technical notes.**

J. E. CLIFFORD

*Water, Maritime and Energy*, 1994, 106, No 4, 353-354

A series of technical notes on the engineering of breakwaters and coast defences are introduced. These notes covered several aspects of interest in developing techniques for coastal engineering. Topics covered included: an overall design of coastal structures, numerical modelling of wave/structure interaction, the development of probabilistic techniques and their application to seawall overtopping, the overtopping of revetment structures, the engineering of vertical faced structures, and the practical aspects of specifying and placing rock armour. **U.K.**

95-1049

## **Wave overtopping of seawalls, breakwaters and shoreline structures.**

N. W. H. ALLSOP (HR Wallingford)

*Water, Maritime and Energy*, 1994, 106, No 4, 355-357

This technical note is one of a series on breakwaters and coastal defences. Information available to coastal and dam engineers on wave overtopping of breakwaters, seawalls, coastal revetments and embankment dams is overviewed. Wave and structural parameters influencing overtopping are discussed. Design methods for estimating wave run-up and overtopping discharge and volumes are presented. Limitations of present design methods are examined and guidance on levels of overtopping to be used in design work is given. **U.K.**

95-1050

## **Numerical modelling of wave-structure interaction.**

J. W. van der MEER (Delft Hydraulics, Emmeloord)

*Water, Maritime and Energy*, 1994, 106, No 4, 359-362

This technical note is one of a series on breakwaters and coastal defences. The various numerical models available for simulating wave structure interaction are described. Assumptions and developments are discussed for the 3 model types: one-dimensional models based on the long-wave equations, potential theory models, and Navier Stokes models. Examples are given of each of the model types. The applications, advantages and disadvantages of each model are discussed. **Netherlands**

95-1051

## **Vertical face breakwaters and seawalls.**

H. OUMERACI (Technische Universität Braunschweig)

*Water, Maritime and Energy*, 1994, 106, No 4, 363-366

This technical note is one of a series on breakwaters and coastal defences. The engineering of vertical face structures is overviewed. The limitations of present design methods for these structures are discussed together with lessons learned from vertical breakwater failures. The key results of an EC research project being carried out under MAST I are summarized. The principal tasks of the MAST 2 project investigations are outlined. **Germany**

95-1052

## **Probabilistic design of rubble mound breakwaters: the way ahead.**

J. D. MEFTAM (Scott Wilson Kirkpatrick)

*Water, Maritime and Energy*, 1994, 106, No 4, 367-370

This technical note is one of a series on breakwaters and coastal defences. The development of probabilistic techniques is discussed. Results of the Working Group 12 of PLANC PTC II in the development of a new method of probabilistic design of rubble mound breakwaters are presented. This method utilized partial coefficients to formulate design of the structure against a certain probability of failure. Practical application by design engineers is considered and suggestions are given for improving the codes of practice. **U.K.**

95-1053

## **Specification and measurement of rock for coastal structures and breakwaters.**

J. D. SIMM (HR Wallingford) and J. P. LATHAM

*Water, Maritime and Energy*, 1994, 106, No 4, 371-376

This technical note is one of a series on breakwaters and coastal defences. Developments in the understanding of how coastal rock structures respond to and influence incident wave and tidal condi-

tions are outlined. Principal points of the recently published CIRIACUR Manual on the use of rock in coastal and shoreline engineering are summarized. Standardized approaches to specification and measurement for payment are outlined. Key data from the manual are given. The practical aspects of specifying and placing rock armour are discussed. U.K.

95-1054

**Coastal defence structures.**

R. S. THOMAS (Postford Duvier Limited, Peterborough)  
*Water, Maritime and Energy*, 1994, **106**, No 4, 377-380.

This technical note is one of a series of breakwaters and coastal defences. The overall design of coastal defence structure is over-viewed. The following areas are examined: the coastal defence system, the environment and the structure. Recent changes in structure design are discussed including the use of rock, increasing environmental awareness and developments in modelling and understanding of coastal processes. U.K.

95-1055

**Risk assessment of coastal defences.**

I. H. TOWNEND (ABP Research & Consultancy Ltd, Southampton)

*Water, Maritime and Energy*, 1994, **106**, No 4, 381-384.

This technical note is one of a series on breakwaters and coastal defences. The development of probabilistic design techniques is outlined. A simple case of seawall overtopping is used to illustrate and compare several available methods. The results are compared with those obtained using conventional deterministic design methods and an analysis based on real data. The variability between the different techniques is discussed. U.K.

95-1056

**A numerical study of the interaction of tidal oscillations and non-linearities in an estuary.**

C. E. SCOTT (Technology University, Loughborough)

*Estuarine, Coastal and Shelf Science*, 1994, **39**, No 5, 477-496.

A 2-dimensional numerical estuarine circulation model that could compute 3-dimensional velocity and salinity structure over a cross-section was developed to investigate interactions between tidal oscillations and buoyancy in a wide tidal estuary. The governing equations were applicable to estuaries with a small tidal range to depth ratio and it was assumed that estuaries were generally much longer than they were wide or deep and that they were locally prismatic. Qualitative and quantitative validation using data from 2 field studies of different sections of the Conway estuary showed that the numerical model reproduced the gross features of observed circulation and salinity structure. Lateral mixing appeared to have a strong effect on longitudinal momentum balance, hence vertical and lateral shear. Field measurements would be required to resolve a storage effect near the shallow banks to estimate the dispersion coefficient which showed a strongly asymmetrical intra-tidal variation. U.K.

95-1057

**The subtidal Lagrangian current in Delaware's inland bays under low wind conditions.**

X. LU (Delaware University, Newark) and K. C. WONG

*Estuarine, Coastal and Shelf Science*, 1994, **39**, No 4, 353-365.

This study focuses on the subtidal Lagrangian current in Delaware's inland bays as measured by LORAN-C and satellite (ARGOS) tracked drifters released in January and April 1992. Local correc-

tions were made for the LORAN-C position data and then inter-compared with the concurrent ARGOS data. The subtidal currents were examined based on LORAN-C position data obtained under low wind conditions. Current velocities were usually less than 3.0 cm per second in the bays, with larger current (5.5 cm per second) occurring near the Indian river inlet. In January, subtidal current and wind were favourably correlated with a complex correlation coefficient of 0.78 and an average veering of about 3 degrees. A poor correlation occurred between current and wind vector time series in April. U.S.A.

95-1058

**Estimation of mean flow velocity in ice-covered channels.**

M. L. TITAI (WEST Consultants, Carlsbad, Calif.), R. TUTTMA and J. E. WALKER

*Journal of Hydraulic Engineering*, 1994, **120**, No 12, 1385-1400.

Flow velocity in ice-covered channels was investigated. Point measurement methods for estimating the mean velocity of vertical distributions of stream-wise velocity in such channels were evaluated. Profiles generated numerically, based on a 2-power law description of the vertical distribution of stream-wise velocity, were used. The 2-power law simplified to the power law expression for open water velocity profiles. The profiles were representative of flows subject to various combinations of bed and ice cover conditions. Values of estimation bias were found for several point measurement methods. The method with the least overall bias was the conventional 2-point method. U.S.A.

95-1059

**Aspects of the hydrology and hydrography of Loch Lomond.**

J. C. CURRAN (Clyde River Purification Board, Glasgow) and I. POODIE

*Hydrobiologia*, 1994, **290**, No 1/3, 21-28.

Available data on the hydrology and hydrography of Loch Lomond are reviewed. A considerable quantity of archived information was available on the climatology and hydrology of the catchment, but little analysis had been conducted, other than for major hydroelectric or extraction schemes. Rainfall and river flows, artificial influences on the hydrology of the loch and trends in runoff are examined. With respect to the hydrography of the loch, temperature structure, circulation and turbulence are reviewed. The sediment balance in the catchment and the effects of the Leven river barrage which raised the mean level in the loch slightly are considered. U.K.

95-1060

**A historical perspective on the provision of a water supply to Saddleworth, a Pennine district.**

K. LAWTON (Manchester City Council)

*Municipal Engineer*, 1994, **103**, No 4, 203-214.

The historical development of the provision of a water supply to the urban district of Saddleworth, a Pennine district north of Manchester is described. The construction of Chew reservoir and of the Ashton under Lyne, Stalybridge and Dukinfield waterworks is detailed. Excavation and construction details are given for the reservoir together with various operational statistics. Work of the Oldham Corporation Waterworks Department is outlined. U.K.

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**95-1061**

### **Work begins on Cardiff bay barrage**

**S. McORMACK**

*Contract Journal* 1994, 376, No 5999, 20/21

Following granting of Royal Assent for the scheme, dredging works had started on the 152 million pounds sterling Cardiff bay barrage by contractors Balfour Beatty/Costain. Extensive preparation had been carried out by consultant Sir Alexander Gibb and Partners before the project had begun to ensure that all design and environmental concerns had been dealt with. These included extensive nuisance mitigation measures and carefully planned contract management together with cost effective construction methods. The barrage was a key part of the revitalization of Cardiff's declining maritime quarter by the Cardiff Bay Development Corporation. The S shaped barrage 1.1 km long and 75 m wide at sea level, would run from Queen Alexandra Head to Penarth, impounding the Taff and Ely rivers. Construction work to date is described together with noise mitigation measures. **U.K.**

**95-1062**

### **Filling of fish**

**K. HAYWARD**

*Water & Environment Management* 1994, No 22, 16/17

The Tawe barrage in Wales was completed in 1992 and incorporates a fish pass, 2 overflow weirs and a lock. It is overtopped during 70 per cent of high tides so that seawater can pass upstream of the barrage. Saline water passing the impoundment tends to settle below the less dense freshwater if there is no mixing. Without mixing the oxygen levels tend to drop. A week after completion of the barrage stratification was noted, with oxygen levels of less than 5 mg per litre in the bottom third of the water column. During high river flow there was ample mixing. In June 1994, high temperatures and low river flows coincided and oxygen levels fell. Swansea council responded to the National Rivers Authority's request for action by opening penstocks in the barrage, drawing up deeper water with a pump and spraying it back to mix the water column. Lessons to be learnt from the Tawe barrage are discussed. **U.K.**

**95-1063**

### **Monitoring of rockfill dams: the case of Wadi Arab dam in Jordan**

**A. S. AL-HMOUD** (Jordan University of Science and Technology, Irbid) and **F. H. AHMED**

*Water Resources Journal* 1994, No 180, 51/63

Monitoring arrangements for the Wadi Arab rockfill dam near Irbid in northern Jordan are reviewed. The dam was of zoned rockfill construction with a clay core. Measuring apparatus was installed to monitor leakage of water, groundwater movement and settlement. Monitoring results suggested that there was no risk from total leakage, though continued attention to the accuracy of leakage measurement was necessary. The dam, its foundation and the left and right banks were judged to be stable, but investigation of certain abnormal measurements was recommended. Additional recommendations included measurement of sediment in the reservoir, particularly at the entrance to the diversion tunnel. There are 35 references. **Jordan**

**95-1064**

### **The Three Gorges project goes ahead in China.**

**P. JIAZHENG** (Ministry of Energy, Beijing) and **Z. JINSHENG**

*Water Resources Journal* 1994, No 180, 77/79

The status of the Three Gorges project in China, involving the construction of a large dam at the steepest section of the Yangtze

river, is examined. The project was designed to bring flood control, electricity generation, navigation and other benefits to the country. The major benefits envisaged are summarized. Problems involved in the project included the resettlement of a population of 725,500 people from the area likely to be submerged, together with the loss of 23,793 ha of farmland, certain adverse environmental impacts, and reservoir sedimentation problems. The construction programme and funding aspects are indicated. **China**

**95-1065**

### **Construction of Maentwrog new dam.**

**J. E. TRIPP** (Nuclear Electric), **J. DAVIE** and **M. P. SHEFFIELD**  
*Water, Maritime and Energy* 1994, 106, No 4, 299/310

The construction of Maentwrog new dam across the gorge of the Afon Prysor, which drains the reservoir catchment of Trawsfynydd Lake for both the nuclear and hydroelectric power stations, is described. The new dam was built to replace the original dam commissioned in 1928, now suffering from progressive deterioration. The special features of dam construction are discussed including the proving of the concrete aggregate, the proximity of the existing structure and the technical measures taken to limit concrete temperatures and to place the concrete. Measures undertaken to limit environmental damage are also described. **U.K.**

**95-1066**

### **Stormwater runoff management: are real water quality problems being addressed by current structural best management practices?**

**G. T. LEE** (G. Fred Lee & Associates, El Macero, Calif.) and **A. JONES III**

*Public Works* 1994, 125, No 12, 53/55 and 70

The effectiveness of structural stormwater control devices installed throughout the U.S.A. in performing the job for which they were designed is questioned. Present activities in stormwater quality management had evolved from the U.S. EPA's National Urban Runoff Programme. Water quality management practices are examined together with stormwater discharge regulation and control, particularly best management practices. The need for reliable assessment of chemical and physical characteristics of the stormwater runoff is discussed. The duration of organism, a key element in aquatic toxicology, is also examined. **U.S.A.**

**95-1067**

### **Modelling groundwater changes due to fluctuating dam discharge**

**M. BUDHU** (Arizona University, Tucson), **D. N. CONTRACTOR** and **C. S. WU**

*Applied Mathematical Modelling* 1994, 18, No 12, 665/671

The capability of 2 numerical models to predict phreatic surface changes due to transient flow was tested against field data recorded at an instrumented sand bar in the Colorado river where operation of the Glen Canyon dam resulted in fluctuating river stage and groundwater levels. Model predictions were in good agreement with field data particularly during rising river stage. A finite element coupled seepage stress consolidation analysis using Biot's consolidation theory appeared to give better overall predictions but a boundary element solution of Laplace's equation offered significant advantages in data preparation and computational time. **U.S.A.**

95-1068

**Transient flow of water to a well in an unconfined aquifer: applicability of some conceptual models.**

T. N. NARASIMHAN (California University, Berkeley) and M. ZHI

*Water Resources Journal*, 1994, No 180, 14-28

The development of analytical solutions for interpreting drawdown data from unconfined aquifers is considered, with particular attention to the assumption that flow in the unsaturated zone had little effect on flow in the aquifer. Numerical experiments on sand columns cast doubt on the empirical assumption of Boulton that the drainable water associated with the specific yield was gradually released at the water table as an exponential function of time. It was proposed that a physically comprehensive model of radial flow in an unconfined aquifer would combine time-dependent drainage from above the water table with vertical components of flow in the saturated zone. There are 30 references. U.S.A.

95-1069

**Determining the range of predictions of a groundwater model which arises from alternative calibrations.**

R. J. BROOKS (Birmingham University), D. N. FERNER and A. M. TOBIAS

*Water Resources Research*, 1994, 30, No 11, 2993-3000

The choice of parameter values for groundwater models is considered, with particular attention to the range of predictions produced by alternative calibrations. A method for the estimation of the prediction variation was developed. A case study concerning the water table under the city of Birmingham (U.K.) showed the possible scale of the variation. The simplification and uncertainties involved in the modelling process and the nature of the parameter identification problem or inverse problem were examined. The proposed method identified the best case and worst case predictions among the plausible parameter sets. Widely different feasible parameter sets giving markedly different predictions were found in the case study. U.K.

95-1070

**Development of an optimal control system for maintaining minimum groundwater levels.**

D. TANKERSEY (Jones Edmunds and Associates Incorporated, Gainesville, Fla.) and W. D. GRAHAM

*Water Resources Research*, 1994, 30, No 11, 3171-3181

A discrete transfer function optimal control scheme was developed to reduce the expected deviation of piezometric head from monthly target levels. The control strategy was generated from a Box-Jenkins flexible input/single output transfer function (SARIMAX) model relating local piezometric head fluctuations to an ecologically sensitive relation to regional rainfall and pumping volumes. An application of the strategy to a localized region of the Upper Floridan aquifer in north east Florida showed that the number of deviations below target head levels could be reduced by 79 per cent and the mean deviation below target by 72 per cent by a 29 per cent reduction in pumping volume. There are 37 references. U.S.A.

95-1071

**Fossil water or renewable resource: the case for one Arabian aquifer.**

R. D. FAULKNER (New England University, N.S.W., Australia)

*Water, Maritime and Energy*, 1994, 106, No 4, 325-331

A 3 year field study had been carried out into the water and soil resources of the eastern side of Saudi Arabia. This region was

underlain by the extensive Umm El Radhuma limestone aquifer. The study included geological surveys, isotope studies, hydrological modelling and estimation of annual water loss and recharge. Factors influencing recharge and discharge of the aquifer are discussed. Despite wide annual variations, the recharge was similar in size to the sabkha discharge, indicating that the aquifer was essentially in balance and that abstractions for irrigation were not necessarily detrimental. Saudi Arabia.

95-1072

**Money down the drain.**

I. EDWARDS

*Water Bulletin*, 1994, No 630, 13-14

Efforts about to be made by the National Rivers Authority to reduce incidents of oil pollution of surface water and groundwater are outlined. In 1993, oil pollution incidents were equal in number to sewage pollution incidents, each contributing 25 per cent of the total. An information and publicity campaign, directed chiefly at the general public and small scale traders in oil, is planned to give general awareness of problems caused by indiscriminate disposal of waste oil, and to inform oil users of the availability of property disposal arrangements. Collection of used oil from garages is already effected by firms belonging to the Chemical and Oil Recycling Association, domestically used oil being classed as household waste, should be collected by local authorities. The National Rivers Authority literature will inform on how to locate the oil disposal banks provided by such authorities. Some water companies have already sent out similar information to their customers. The storage arrangements made by large scale traders have been found generally satisfactory. U.K.

95-1073

**Adapting ozonation for soil and groundwater cleanup.**

C. H. NELSON (Groundwater Technology Inc., Englewood, Colo.) and R. A. BROWN

*Chemical Engineering*, 1994, 101, No 11, 1118-1119 and 1121-1122

Ozone is a powerful oxidizing agent that is very effective in treating hazardous organic compounds, including chlorinated ethanes and complex aromatic, which are often resistant to more traditional treatment schemes. Among the advantages associated with ozone is its much greater solubility in water than is the case with oxygen, and the very rapid oxidation that occurs often within seconds. Groundwater or soil ozonation can be carried out *in situ* or within above-ground treatment cells, and work equally as either the primary treatment method or a final polishing technique. The emergence of *in situ* ozonation techniques for groundwater and soil remediation is a direct result of advances made in air-sparging technology in the last 2 years, in which the controlled injection of air strips organic compounds from the groundwater and soil or supplies oxygen for oxidation or biodegradation. U.S.A.

95-1074

**Horizontal piping grid speeds site cleanup.**

S. WALSH

*Chemical Engineering*, 1994, 101, No 11, 1124-1125

Horizontal Technologies Inc. (Cape Coral, Fla.) has developed the LCRS (Linear Containment Remediation System) to recover petrol, fuel oil, solvents and other hydrocarbons lost to groundwater and soil. Essentially, LCRS is a system of horizontal perforated high-density polyethylene pipe to increase exposure to the spill by pumping water to draw the contaminated plume towards the vertical risers.



and thus to the surface. The LCRS is a cost effective alternative to traditional pump and treat systems, and is easily and quickly installed. The system can be installed to a depth of 25 ft, although depths up to 35 ft can be reached. Air sparging may be employed to volatilize the volatile organic compounds present in the groundwater and contaminants can be removed as a vapour stream, again reducing the total treatment volume. U.S.A.

95-1075

## A geographic information systems approach to wellhead protection.

J. L. HAMMEN (North Dakota University, Grand Forks) and P. J. GERLA

*Water Resources Bulletin*, 1994, 30, No 5, 833-840

The 1986 Amendments to the Safe Drinking Water Act focused on protecting municipal wellfields through a multifaceted approach. Programme elements included delineation of wellhead protection areas, identifying and managing potential contaminants, developing contingency plans and locating new well sites to use in the event of wellfield contamination and encouraging public participation. A geographic information system (GIS) provides a mechanism whereby all components of a comprehensive wellfield protection strategy can be addressed. The application of a GIS to the development of a wellhead protection scheme for Laramore, N. Dak., U.S.A., is described. The potable water supply of Laramore was threatened by municipal and agricultural point and non-point source pollutants. U.S.A.

95-1076

## Assessment of long-term withdrawal rate for a coastal aquifer.

A. DAS GUPTA (Asian Institute of Technology, Bangkok, Thailand) and H. B. M. P. AMARAWETTERA

*Water Resources Journal*, 1994, No 180, 64-74

A method for assessing the long-term rate of safe withdrawal from a coastal aquifer was developed and evaluated in the case of Mannar island off the coast of Sri Lanka. The movement of the interface between fresh and salt water in conditions of withdrawal was simulated. A range of estimates of the natural recharge was first obtained from a water balance study. The representative recharge sequence was then determined by a simulation of an interface profile along a selected section. The sustainability of continuous withdrawal was assessed by limiting the extent of salt water upconing. Increases in withdrawal were possible through careful monitoring of the system response. Sri Lanka.

95-1077

## Simulation of surfactant-enhanced aquifer remediation.

C. E. BROWN (Texas University, Austin), G. A. POPE, L. M. ARRIOLA and K. SEPTEIRNOORI

*Water Resources Research*, 1994, 30, No 11, 2959-2977

A comprehensive model of surfactant-enhanced aquifer remediation (SEAR) was developed and used to explore the potential of this technology on an aquifer scale as an alternative to conventional pump and treat remediation of aquifers contaminated by dense non-aqueous phase organic liquids. The model incorporated the complex chemistry and multi-phase transport behaviour of surfactant/water/organic mixtures in permeable media. Important issues potentially affecting SEAR performance at the field scale were explored using the model. Simulations suggested the feasibility of reducing the total time for remediation by an order of magnitude using SEAR. There are 46 references. U.S.A.

95-1078

## Preventing pesticide contamination of groundwater while maximizing irrigated crop yield.

R. C. PERALTA (Utah State University, Logan), M. A. HEGAZY and G. R. MUSHARRAFIEH

*Water Resources Research*, 1994, 30, No 11, 3183-3193

An optimization model which described the relationship between irrigation management and pesticide leaching through the unsaturated zone was developed to maximize irrigated crop yield while avoiding unacceptable pesticide leaching. Optimal irrigation amounts were computed for given soil, crop, chemical and weather data and irrigation frequencies. The minimal irrigated crop yield reduction needed to prevent groundwater contamination was computed directly. The model was tested for various maize irrigation scenarios. The approach adopted was promising as a way of developing environmentally-sound agricultural production practices. There are 44 references. U.S.A.

95-1079

## Environmentally appropriate operation of a drinking water reservoir, having regard to water supply power generation and mandatory water release.

J. GIESECKE (Universitat Stuttgart), H. B. HORLACHER, J. RAPP and W. ZHANG

*Wasserwirtschaft*, 1994, 84, No 11, 608-610 and 612 (in German, English summary)

The operation of the Kleine Kinzig reservoir situated just south of Freudenstadt in the Black Forest is discussed against a background of the possible conflicts between the demands of water supply, hydroelectric power production and minimal discharge level in the downstream part of the catchment. The reservoir is a 71 m high rockfill dam with an asphalt core designed to assure a supply of drinking water to around 150 000 local inhabitants. At the same time one of its principal functions was the generation of electricity from 2 Francis turbines of 220 kW or 360 kW output at a controlled discharge of 500 litres per second or 700 litres per second. Other factors which must be taken into account are the water levels at various points downstream on the Kleine Kinzig river as far as its confluence with the Kinzig. A study of hydrological records for gauging stations in the catchment enabled a time series covering 73 years from 1912 to 1984 to be constructed, with a minimal annual flow of 6.73 hm<sup>3</sup> in 1921 and a maximum of 388.2 hm<sup>3</sup> in 1965, the mean value being 20.65 hm<sup>3</sup>. Further studies with the aid of time series analyses and probability estimates enabled a predicted time series for future years to be obtained and used as input to a simulation model of reservoir operation. It would be possible to fulfil the demands for power generation and compensation water without detriment to the drinking water supply under all foreseeable conditions. (English translation 170 pounds sterling, valid for 1995). Germany.

95-1080

## Forecasting domestic water demand and the effect of economy measures.

B. W. DANIELS (IVEM), G. E. ACHTTENRIJBE and A. J. M. SCHOOIJ

*H2O*, 1994, 27, No 25, 736-739 (in Dutch, English summary, p. 727)

A more refined method of forecasting domestic water demand than that based on extrapolation of past trends was sought in 1992 by VFWIN, the Dutch association of water suppliers. In the survey conducted the influence of social and demographic factors, such as

the availability, and in what proportion of households of facilities such as baths, showers, and washing machines and the extent of their use was examined. A computer model was built indicating the influence of major water using functions on the likely total national demand over the next 20 years, the construction of the model and some of its forecasts, are detailed. (English translation 210 pounds sterling valid for 1995) **Netherlands**

95-1081

**Command area water demands. I: validation and calibration of UCA model.**

S. YAMASHITA (Utah State University, Logan) and W. R. WALKER

*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 6, 1025-1042

The Unit Command Area (UCA) computer simulation model that predicted the water demand by an aggregated population of fields served by a canal turnout by accounting for field management factors was validated using field data for 5 UCAs from an existing on demand irrigation system throughout one crop season. Comparison of the model generated cumulative water demand curves with actual water supply hydrographs showed that the accuracy of predicted demand was generally acceptable but highest for the 3 largest UCA (83-311 ha). Model calibration was achieved by adjusting the key variables of management allowable depletion, irrigation application uniformity and initial soil moisture which could all be defined by water users during system operation. (see also following abstract) **U.S.A.**

95-1082

**Command area water demands. II: water-demand function.**

S. YAMASHITA (Utah State University, Logan) and W. R. WALKER

*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 6, 1043-1055

The logistic curve was used to approximate the cumulative water demand (CWD) for a 311 ha unit command area (UCA) in an existing on demand irrigation system. Multiple regression analysis determined significant relationships between logistic function parameters and the 3 key factors (management allowable depletion, irrigation application uniformity and initial soil moisture) used to calibrate the UCA model which predicted the aggregate water demand of individual command areas throughout a crop season. The developed model for CWD approximation was validated using 5 data sets and application to 2 smaller UCA (83 and 100 ha) respectively in the same system demonstrated the generality of the developed equations. Under conditions of limited water supply the developed equations could be used to determine water application strategy. (see also preceding abstract) **U.S.A.**

95-1083

**No growth in water demand expected for 20 years.**

*Water News*, 1994, No 58, 5-7

The water industry's projections for water demand over the next 20 years, as formalized in their Strategic Business Plans, are summarized and their probable accuracy discussed. The amount put into supply was expected to rise by barely 0.5 per cent, a rise in supplies to households was expected to be virtually counterbalanced by a fall in supplies to non households and a reduction of leakage. The estimates assume that on household demand would be reduced by an extension of metering (5 per cent of households now, 30 per cent by 2015), a continued decline of water intensive manufacturing industry and much more effective leakage control. Whether the 1994

K factor applied would give utilities enough profit to effect leak repair on the scale envisaged and whether meter introduction would be on the scale postulated are major uncertainties. Nationally there was little imbalance between resource availability and probable demand but a regional problem in south east England is admitted **U.K.**

95-1084

**Basis of a new water policy - based on research and experience in the Frankfurt/Main Public Works Department.**

H. SOMMER (TU Berlin)

*GWFA Wasser/Abwasser*, 1994, 135, No 11, 648-650 (in German, English summary)

A seminar organized by the Frankfurt am Main water undertaking took place on 21st and 22nd June 1994 to discuss the outcome of a project sponsored by the Federal Ministry of Research and Development and composed of 2 sub projects, one of which was concerned with water conservation and rational utilization and the other based on Dresden considered the possibilities connected with water space in inner city advanced in respect of water conservation are reviewed with estimates of savings area. The proposals possible in a number of major cities due to a variety of techniques including mains rehabilitation, recycling and reuse of water within locally defined areas, improved levels of sewage treatment allowing reuse of final effluents and in extension of process water supplies for operations not requiring high quality drinking water. The experience of the water undertaking serving the city of Frankfurt was reviewed where consumption had declined steadily since 1991 despite a slight positive trend in population growth. Due to strenuous remedial efforts distribution system losses in the former West German cities were mostly less than 5 per cent while for Dresden the loss remained around 30 per cent. (English translation 100 pounds sterling valid for 1995) **Germany**

95-1085

**The effectiveness of pricing as a stand-alone water conservation programme.**

J. L. JORDAN (Georgia University, Griffin)

*Water Resources Bulletin*, 1994, 30, No 5, 871-877

Economic theory indicated that the use of increasing rate structures would reduce the demand for water and produce monetary incentives for consumers to conserve water. Recent studies on the use of pricing to encourage water conservation are reviewed. The implementation of an increasing rate structure in Spalding County, Ga., U.S.A., where no other conservation programme is used, is described. The increasing rate structure was implemented in 1991. By 1993 the number of customers of the Spalding County Water Authority had increased by 21 per cent while total water demand had increased by 15 per cent and per customer water use had declined by 5 per cent. The daily water use per connection decreased from 243 gallons in 1990 to 231 in 1993. **U.S.A.**

## WATER QUALITY

See also Abstracts 95-1011, 95-1013, 95-1018, 95-1172, 95-1180, 95-1216, 95-1217, 95-1478, 95-1479, 95-1480, 95-1481

95-1086

**Water quality models: tools for the analysis of data, knowledge, and decisions.**

O. VARIS (Helsinki University of Technology, Finland)

*Water Science & Technology* 1994, 30, No 2, 13-19

Twenty seven case studies on water quality and fisheries management, which used a variety of computational techniques, are summarized. The approaches varied between empirical, deterministic and pragmatic. The roles of inductive and deductive components in inference are discussed; approaches are examined concerning decision support and scientific aspects of the studies. The contributions of logical and relational thinking, and experience are considered. Decision support is discussed, starting from the needs of directive, strategic, tactical and operational management. A variety of problem-solving tools needed to be utilized to cope with the multiple tasks addressed by water quality models, including data analysis, knowledge processing and decision support. **Finland**

95-1087

**AQUASIM - a tool for simulation and data analysis of aquatic systems.**

P. REICHERT (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf)

*Water Science & Technology* 1994, 30, No 2, 31-40

A new simulation and data analysis program for laboratory, technical and natural aquatic systems is described. The 4 sub-systems comprising AQUASIM were links, compartments, processes and variables; each is described. The spatial configuration was represented by the compartments. The user could define an arbitrary number of substances to be modelled, with flexibility in the formulation of transformation processes. The program allowed simulations, sensitivity analyses, parameter estimations and uncertainty estimations to be performed. These features and the user-friendly interface provided support for data analysis. Three examples illustrate the program capabilities. **Switzerland**

95-1088

**Identification and application of a dynamic model for operational management of water quality**

M. B. BLACK (Georgia University, Athens, U.S.A.) and A. REDA

*Water Science & Technology* 1994, 30, No 2, 31-41

Recent progress on a previously reported integrated approach to water quality control in river catchments is reported, concentrating on the in-stream water quality model. This was based on a multiple continuously stirred tank reactor approximation of fluid and solute propagation along a river system. Changes to the hydraulic basis had improved the model. It was calibrated by a data set of field observations from the Cam river, eastern England. This also tested the model capabilities concerning solute transport and the biochemical interactions among BOD, dissolved oxygen, inorganic nitrogen and chlorophyll *a* concentrations. It assessed management and real-time control strategies for attenuating the adverse effects on stream water quality of storm-sewage surges passing through the sewers and the wastewater treatment plants. This included the coordinated manipulation of in-stream structures to improve controlled performance.

Reasonable agreement was obtained between field data and simulations. **U.K.**

95-1089

**An analysis of the effect of an upstream reservoir by means of a mathematical model of reservoir hydrodynamics.**

G. HOCKING (Western Australia University, Nedlands, Australia) and M. STRASKRABA

*Water Science & Technology* 1994, 30, No 2, 91-98

The differences in temperature stratification and flows in a solitary reservoir and the same reservoir relatively close downstream to another reservoir were simulated by the 1-dimensional numerical hydrodynamic model DYRESM which was generally applicable without calibration for a specific site. The reservoir in the second case was termed a cascade reservoir. The inflow to this reservoir changed from an undammed river to the regulated flow from the hypolimnion of the upstream reservoir. The change in inflow temperatures showed as a more pronounced stratification in the cascade reservoir and lower surface temperatures. The heat budget changed because the cascade reservoir, being colder, took up more heat from the air. Sedimentation, phosphorus uptake and organic matter decomposition in the upstream reservoir caused turbidity, phytoplankton concentrations and colour to be lower in the cascade reservoir. **Czech Republic**

95-1090

**Limnology of high arctic ponds (Cape Herschel, Ellesmere Island, N.W.T.)**

M. S. V. DOUGLAS (Queen's University, Kingston, Ont.) and J. P. SMOL

*Archiv für Hydrobiologie* 1994, 131, No 4, 401-434

The limnological changes were monitored over 4 field seasons in 36 high arctic ponds, Cape Herschel, east central Ellesmere Island. Ponds froze completely for 10 months but during the short summer water warmed substantially giving a record of 17°C and fluctuated diurnally. Ponds were shallow, clear, oligotrophic and were alkaline (pH 7.4-8.6) with the exception of one site. Conductivity fluctuated seasonally between 100 and 300 µS, however a tidally influenced brackish pond had a conductivity of 10-393 µS and the dilute Paradise pond had minimal conductivity of 22 µS. Major ion concentrations were relatively similar with calcium and sodium being the major cations and chloride the major anion. Concentrations changed over the summer due to cryoconcentration, snowmelt dilution, evaporation and other variables. These ponds were much more responsive than nearby lakes to environmental changes. There are 43 references. **Canada**

95-1091

**Influence of some environmental factors on the freshwater macroinvertebrates distribution in two adjacent river basins under Mediterranean climate. I. Dipteran larvae (excepting chironomids and simuliids) as ecological indicators.**

A. GALLARDO (Universidad de Sevilla) and I. PRENDA

*Archiv für Hydrobiologie* 1994, 131, No 4, 435-447

Some aspects of the ecology of the freshwater dipteran larvae assemblage were examined in 2 river basins in southern Spain differing in the physico-chemical characteristics of their water and their temporality through the hydrological cycle. The distribution of taxa preferences in the 2 principal factors space (relating to conductivity, nitrite, nitrate and alkalinity) were classified into 4 groups. *Helius* sp., *Simobezzia* sp., *Bettus* sp. and *Oxycera* sp. preferred the more saline sites and avoided high nitrite concentrations. *Tipula* sp.

*Pericoma* sp. and *Wiedemannia* sp. preferred the higher nitrate and lower nitrite concentrations. *Dicranota* sp., *Tubanus cordiger* and *Tubanus bromius* avoided sites with higher nitrite concentrations. *I. phyllus* sp. did not display any preference for any of the parameters analysed. Most taxa were collected in sites with vegetation cover and moderate values of water current (see also following abstract). Spain

## 95-1092

**Influence of some environmental factors on the freshwater macroinvertebrates distribution in two adjacent river basins under Mediterranean climate. II. Molluscs.**

A. GALLARDO (Universidad de Sevilla), J. PRENDA and A. PUJANTE

*Archiv für Hydrobiologie*, 1994, 131, No 4, 449-463

The freshwater mollusc assemblages and their relationship to some physico-chemical parameters and water persistence were examined in 2 river basins in southern Spain with differing physico-chemical conditions. Two associations of species were found: one grouped according to geographical distribution, uninfluenced by water persistence or physico-chemical conditions; the other according to abundance where species assemblages were accidental or due to different successional states. Most species and/or assemblages were distributed in the same way as availability of physico-chemical conditions. Exceptions were *Lymnaea truncatula* which preferred the less eutrophic lentic sites in Guadaira basin, *Mercatula confusa* and *Melanopsis dufouri* which preferred higher altitude and more saline sites in Guadaira basin, and *Potamopyrgus jenkinsi*, *Lymnaea stagnalis*, *M. dufouri*, *Anodonta filiculus* and *Physidum* sp. which were more abundant in higher altitude sites and during non-flooded periods in Guadalete basin. Molluscs were of limited value as environmental indicators of particular conditions in stressed streams or those with high ionic concentrations. There are 32 references. (see also preceding abstract). Spain

## 95-1093

**Zooplankton in loch Lomond: perspectives, predation and powan**

G. P. POMEROY (St. Andrews University)

*Hydrobiologia*, 1994, 290, No 1/3, 75-90

The existing state of knowledge of the zooplankton community in loch Lomond is reviewed. The results of zooplankton surveys undertaken between 1995 and 1987 are compared. The nature of the zooplankton community is also examined with particular reference to predation by fish, especially the facultative planktivore, the powan (*Coregonus lavaretus* L.). Powan feed heavily on zooplankton from late spring until late autumn. They show selectivity in the prey species taken, in the size distribution and morphotypes preferred within prey species. Patterns of zooplankton species, morphs and forms in Lomond loch tend to reflect this predation pattern. There are 58 references. U.K.

## 95-1094

**Water temperature behaviour in the river Danube during the twentieth century.**

B. W. WEBB (Exeter University, U.K.) and F. NOBILIS

*Hydrobiologia*, 1994, 291, No 2, 105-113

Data on water temperature and supporting information on air temperature and river discharge were investigated for the Danube river at Lienz, Austria, for the period 1901-1990. There was a significant increase in monthly mean water temperatures of 0.8°C with strongest rises in mean values for autumn and early winter months. There were

no statistically significant trends for air temperature or river discharge. The influence of snowmelt runoff depressed average water temperatures in the spring and early summer by 1.5°C. Multiple regression relationships for individual months from air temperature, river discharge and time trends were able to predict monthly mean water temperatures in 1991 and 1992 with a root mean square error of 0.5°C. Using these regression equations predictions of future river temperatures were made. There are 43 references. Austria

## 95-1095

**The current status of coral reef management in French Polynesia.**

P. HUTCHINGS (The Australian Museum, Sydney, South S.S.W.), C. PAYRI and C. GABRIEL

*Marine Pollution Bulletin*, 1994, 29, No 1/3, 26-33

Renewable and non-renewable resources associated with the coral reefs of French Polynesia are reviewed. The impact of land runoff, over-fishing, domestic, industrial and agricultural effluents, and tourism are discussed together with legislative means of control. The 3 marine reserves and the protected species legislation are considered with comments on recent planning initiatives which potentially allowed an integrated approach to coastal zone management. The lack of the latter and failure to enforce existing legislation were threatening tourism, fisheries and pearl culture activities which supported much of the islands' economy. There are 51 references. Polynesia

## 95-1096

**A review of the status of Philippine reefs**

F. D. GOMEZ (Philippines University, Quezon City), P. M. ALINO, H. T. YAP and W. Y. TICUANAN

*Marine Pollution Bulletin*, 1994, 29, No 1/3, 62-68

Surveys of the Philippine reefs since 1979 are evaluated and the methodology explained. Early surveys relied on assessing live coral cover; those of the past 2 years employed the more useful coral mortality index. Most reefs were in reasonable condition. Major destructive factors were sedimentation and siltation from coastal development and inland activities, illegal and damaging methods of fishing, and over-fishing. Integrated approaches of coastal area management were needed to protect productive ecological processes. There are 44 references. Philippines

## 95-1097

**An assessment of the status of the coral reefs of Papua New Guinea.**

M. F. HUBER (Papua New Guinea University)

*Marine Pollution Bulletin*, 1994, 29, No 1/3, 69-73

The status, resources and threats to the coral reefs of Papua New Guinea are considered. Primary human exploitation was for subsistence and artisan commercial fisheries. Despite general under-utilization, local over-fishing occurred where there was access to cash markets. Although the reefs were thought to be relatively undisturbed, data for objective assessment were few. Dynamic fishing and sedimentation from forestry, agriculture and mining were the principal threats to the health of reefs. Eutrophication and pollution generally were likely as local problems especially near urban areas. There are 51 references. Papua New Guinea

## WATER QUALITY

95-1098

**Hong Kong's coral communities: status, threats and management plans.**

B. MORTON (Hong Kong University)

*Marine Pollution Bulletin* 1994, 29, No 1/3 74-83

The limited information on Hong Kong's scleractinian coral communities is reviewed and the broad aspects of their distribution explained in terms of a locally complex climate and hydrography. Corals, now restricted to the less polluted oceanic eastern waters, were more widely distributed before the foundation of the colony. Furthermore, collection of coral for lime burning had been common until the 1940s. Coral communities continued to suffer through pollution from economic development and siltation arising from the construction of the Chek Lap Kok airport. Legislation and plans were being formulated to create marine parks and reserves to protect coral communities. In practice, only remnants of what was once a wide-spread coral community would survive in their remotest bays. There are 38 references. **Hong Kong**

95-1099

**Assessment of eutrophication in loch Lomond by desk analysis.**

I. D. M. GUNN (Institute of Freshwater Ecology, Edinburgh), A. F. BAILEY-WATTS and A. A. LYLF

*Hydrobiologia* 1994, 290, No 1/3 51-52

A rapid assessment of the potential for eutrophication in the Lomond loch system was made, using desk analysis of land use and human occupancy of the catchment. Research results on nutrient inputs and the impacts on plankton dynamics were also incorporated into existing eutrophication models. Catchment pressures and the sensitivity of the loch, considered together, enabled loch responses to be evaluated. Phosphorus and chlorophyll *a* levels were predicted on the basis of estimated phosphorus loss coefficients and flushing rates related in accordance with eutrophication models. The resulting values were in close agreement with measured values. **U.K.**

95-1100

**Freshwater and wetland plant communities of loch Lomond.**

K. J. MURPHY (Glasgow University), K. D. HUDSON and J. MITCHELL

*Hydrobiologia* 1994, 290, No 1/3 63-74

The present state of knowledge of the aquatic macrophyte and wetland plant communities of Lomond loch is reviewed. Studies undertaken between 1957 and 1990 are taken into account. Aquatic macrophyte growth was estimated to occupy about 1 per cent of the total loch surface area and to be limited to the 0-10 m euphotic zone. Aquatic vegetation was abundant in sheltered bays and along less exposed shorelines, especially in the southern basin of the loch. Three separate euhydrophyte communities were identified in the loch, one characterized by an abundance of *Elodea canadensis* though the commonest submerged plant in the loch was the ubiquitous *Littorcha uniflora* (L.) Aschers. **U.K.**

95-1101

**Evaluation of the role of submerged plant beds in the metal budget of a fluvial lake.**

L. SÉLYR (Université du Québec, Sainte-Foy), P. G. C. CAMPBELL and K. GUÉRTIN

*Hydrobiologia* 1994, 291, No 3 141-156

The mean submerged biomass at sampling stations in St. Pierre lake, St. Lawrence river system, P.Q., dominated by *Vallisneria spiralis* and *Potamogeton* spp. ranged from 2.6 to 730 g dry weight per m<sup>2</sup> during the peak seasonal biomass (August) and senescence

(October). By combining biomass values and metal concentrations with the more extensive remote sensing data base of biomass values and by using geostatistical estimation techniques (Kriging) the seasonal storage of metals in St. Pierre lake plants were estimated to be 30 kg cadmium, 89 kg chromium, 450 kg copper, 280 kg nickel, 71 kg lead and 2200 kg zinc. During the seasonal biomass peak, the quantities of cadmium, lead and zinc stored in the plants were higher than those dissolved in the water column but lower than those present in the surficial recent sediments. The macrophyte compartment of mass balance calculations for the summer months represented only a small proportion of the metals entering the lake, copper and nickel being less than 1 per cent, cadmium and zinc, 2 per cent and lead 4 per cent. Metals associated with the above-ground parts of submerged vegetation were not recycled within the lake but exported at the end of the summer. There are 56 references. **Canada**

95-1102

**Seasonal occurrence of mesophilic *Aeromonas* spp. as a function of biotype and water quality in temperate freshwater lakes.**

M. W. RHODES (William and Mary College, Gloucester Point, Va.) and H. KATOR

*Water Research* 1994, 28, No 11, 2241-2251

Water samples taken from 6 freshwater lakes in Virginia during 14 months were examined for faecal coliforms, *Escherichia coli*, enterococci and mesophilic aeromonads. The last were enumerated by membrane filter and biotyped according to the scheme of Popoff and of Janda. Chemical parameters were measured, including chlorophyll *a*. Walker's trophic state index was calculated. Data were examined by non-parametric statistical tests. Mesophilic aeromonad densities did not correspond with trophic status in mesoeutrophic to hypereutrophic lakes. There was no correlation between faecal coliform counts and concentrations of mesophilic aeromonads except when sewage pollution was clearly present. *Aeromonas sobria* was dominant in most lakes during the warmer seasons. Their incidence coincided with maximal recreational use and could be a health hazard to sensitive individuals. Haemolysis and autoagglutination were expressed in a significant proportion of isolates from the lake waters. Further studies were required of the relationship of mesophilic aeromonad ecology with virulence and biotypes. There are 72 references. **U.S.A.**

95-1103

**Partial and full lift hypolimnetic aeration of Medical lake, W.A., to improve water quality.**

R. A. SOLETTRO (Eastern Washington University, Cheney), L. M. SIXTON, K. T. ASHLEY and K. O. McKEE

*Water Research* 1994, 28, No 11 2297-2308

Water quality at the deepest point, around 18 m, of Medical lake was assessed in 1984-1986 without aeration, in 1987 when partial hypolimnetic aeration was undertaken and in 1990-1992 when full hypolimnetic aeration occurred. Both systems reduced hypolimnetic total phosphorus and ammonia concentrations, increased temperature and had no effect on chlorophyll *a* levels. Partial aeration had no effect on phytoplankton biovolume, nitrate and dissolved oxygen (DO) levels. Full lift aeration reduced hypolimnetic total phosphorus, ammonia and DO concentrations. The partial system was effective because it prevented the release of phosphorus from the lake's bottom. Continued operation of full lift aeration should further reduce *in situ* oxygen demands leading to a new equilibrium and higher hypolimnetic DO levels. Eventually the prevention of phos-

phorus release was expected to reduce phytoplankton crops. There are 53 references. U.S.A.

95-1104

**Water quality simulation of Te-Chi reservoir using two-dimensional models.**

J. T. KUO (National Taiwan University, Taipei), J. H. WU and W. S. CHU

*Water Science & Technology*, 1994, 30, No 2, 63-72

Eutrophication in the Te-Chi reservoir, Taiwan, was simulated by 2-dimensional laterally averaged hydrodynamic and water quality models, the former developed by the U.S. Army Corps of Engineers and the latter by the U.S. EPA. The water quality model was calibrated and validated with calculated hydraulic results and stream loading data. The combined models then characterized the temperature distribution, seasonal overturning, and variations of chlorophyll *a*, organic nitrogen, inorganic nitrogen, organic phosphorus, inorganic phosphorus and dissolved oxygen in the reservoir. The reservoir was nitrogen rich with phosphorus the limiting factor for algal growth, indicating that reductions in phosphorus input would control phytoplankton. New versions of the models would soon be available to give improved simulations. Taiwan

95-1105

**Assessment and uncertainty analysis of eutrophication for Te-Chi reservoir, Taiwan.**

Y. M. WANG (National Taiwan University, Taipei), M. C. WU and J. T. KUO

*Water Science & Technology*, 1994, 30, No 2, 73-80

The risk of eutrophication in a reservoir was retrospectively evaluated for 1983-1985 by a probabilistic phosphorus model and first order analysis of uncertainty (FOAU) based on load resistance analysis; these yielded risks of 0.245 and 0.626, respectively. The difference was ascribed to the FOAU considering more uncertainty information in the calculation. The trophic state in the future was evaluated by an annual inflow model which combined future synthetic stream flows and the previously developed empirical total phosphorus model. This gave a eutrophication risk of 0.863. The approach was relatively simple. A time dependent reliability model could be considered for further study. Taiwan

95-1106

**Phytoplankton and physical-chemical features of the shallow lake Mikri Prespa, Macedonia, Greece.**

I. TRYFON (Thessaloniki University), M. MOUSTAKA, G. GOUNI, G. NIKOLAIDIS and I. TSEKOS

*Archiv für Hydrobiologie*, 1994, 131, No 4, 477-494

Phytoplankton biomass values in Mikri Prespa lake were between 2 and 38.0 g per m<sup>3</sup> between May 1990 and September 1992 having one autumnal and one vernal peak. Cyanophytes, diatoms, chlorophytes and dinophytes showed relatively distinct patterns of seasonality. Cyanophytes contributed 78.6 and 49.8 per cent in 1990, 1991 and 1991, 1992, respectively, and remained dominant throughout the year. Diatoms contributed 15.3 and 34.9 per cent in successive years, respectively, and dominated in winter and spring. Other classes gave a minor contribution to biomass. Although the periodicity of the phytoplankton and the height of annual peaks resembled those of many temperate lakes, no summer maxima were observed. Temperature and total inorganic nitrogen were important controlling factors for the development of cyanophytes and diatoms and dissolved silica was additionally important for diatoms. Species seasonability was

affected by weather conditions and especially increased rainfall. There are 39 references. Greece

95-1107

**Variability of the biomass, chemical composition and productivity of phytoplankton in Kinu-ura bay, Japan during the rainy season.**

J. HAMA (Institute for Hydrospheric Atmospheric Sciences, Nagoya) and N. HANDA

*Estuarine Coastal and Shelf Science*, 1994, 39, No 5, 497-509

Phytoplankton blooms observed during the rainy season in eutrophic estuaries were investigated by measuring phytoplankton biomass, chemical composition and production and physico-chemical environmental parameters in the semi-enclosed Kinu-ura bay at 1-5 d intervals during May-July. An elevated inorganic nutrient concentration observed in surface waters after rainfall was probably derived from increased freshwater influxes and was followed by changes in dominant phytoplankton species. At 0.5 m the particulate protein/carbohydrate ratio was generally at least 3 indicating there were sufficient nutrients for high growth activity during the rainy season. A production rate of 22.2 g carbon per m<sup>2</sup> d was determined using the carbon-13 method with *in situ* incubation and the organic nitrogen production rate was estimated as 0.47 g nitrogen per m<sup>2</sup> d. The nitrogen supply appeared to be sufficient for primary production during the study period and the chemical composition of particulate organic matter showed no evidence of nitrogen limitation. The results demonstrated the importance of the rainy season to annual primary production in Kinu-ura bay. There are 34 references.

Japan

95-1108

**Phytoplankton blooms and a coastal thermocline boundary along the west coast of Ireland.**

C. M. ROLDEN (The Shellfish Research Laboratory, Carna) and R. RAINI

*Estuarine Coastal and Shelf Science*, 1994, 39, No 5, 511-526

Mixed stratified boundaries or tidal fronts were investigated along the Connemara coast where thermal stratification occurred within 10 km of the shore by collecting surface and subsurface samples over a 5 year period. Temperature, salinity and chlorophyll data showed that the summer thermocline joined the sea bed close to an underwater escarpment rather than outcropping on the surface. Diatom blooms were observed along the mixed side of the boundary in summer with highest cell counts and chlorophyll concentrations recorded in subsurface water the outer ledge or over the escarpment. Bloom development was greatest during spring tides in early summer and at depth and declined shorewards. A decrease in chlorophyll concentrations as summer progressed was associated with the retreat of the thermocline offshore and the increase in bottom water temperature. The occasional development of dinoflagellate blooms in September could be associated with nutrient accumulation below the thermocline. Mechanisms responsible for the appearance of blooms probably included the occurrence of colder more saline water at the escarpment base during spring tides, total mixing of adjoining water masses and horizontal advection. Eire

95-1109

**Preliminary study of management of red tide water by the filter feeder *Mytilus edulis galloprovincialis*.**

S. TAKEDA (Tokohu University, Aomori), and Y. KURIHARA  
*Marine Pollution Bulletin*, 1994, **28**, No 11, 662-667

The ability of mussels (*Mytilus edulis galloprovincialis*) to remove plankton from seawater was investigated. Studies with 4 species of plankton of different lengths showed that the mussels could retain plankton with a major axis larger than 7  $\mu\text{m}$ . The retention rate for *Pavlova lutheri* by the mussels increased with plankton density over the range 100,000 to 5,000,000 cells per ml, and also increased exponentially with mussel shell length. The deposit feeding sea cucumber *Stichopus japonica* was able to ingest mussel faeces, which contained organic matter unabsorbed by the mussels. Mussels may have a useful function in removing red tide plankton and preventing eutrophication, but can only operate where the plankton is not toxic to them. There are 30 references. **Japan**

95-1110

**Whiter than whitewash?**

A. TURNER

*Water Bulletin*, 1994, No 612, 13-14

The link between algal growth and the presence of phosphates in water is challenged by the Scientific Committee on Phosphates in Europe (SCOPE), an organization representing manufacturers of both phosphate containing and phosphate free detergents, and other phosphatic products. Evidence suggested that the zeolite water softening agent used instead of sodium tripolyphosphate in phosphate free detergents had an adverse effect on the degree of predation by zooplankton on algae, and that if this adverse effect was removed the predators could better control an algal bloom. The committee called upon research conducted at the Dutch research organization TNO's Institute of Environmental Sciences to construct an algal control index, which would reflect the rate of algal production divided by the rate of removal; anything over 1 would indicate a potential algal problem. **International**

95-1111

**Nutrient inputs to estuaries from nine Scottish east coast rivers; influence of estuarine processes on inputs to the North sea.**

P. W. BALLS (SOAED Marine Laboratory, Aberdeen)

*Estuarine, Coastal and Shelf Science*, 1994, **39**, No 4, 329-357

The nutrient concentrations in the Tweed, Forth, Tay, Dee, Don, Ythan, Beaulieu/Inverness, firth, Cromarty firth and Dornoch firth were related to land use. River catchments with intensive agriculture and low freshwater input (Don and Ythan) had enhanced nitrate (up to 600  $\mu\text{M}$ ) and phosphate (up to 5  $\mu\text{M}$ ) in their estuaries. Highland river catchments with mineral poor soil, low populations and low agricultural intensity (Inverness, Cromarty and Dornoch firths) had low nutrient concentrations in rivers compared to coastal seawater. There was conservative mixing of dissolved nutrients in short, rapidly flushed estuaries (Tweed, Don and Ythan). For large, slowly flushed estuaries (Forth, Tay and Dornoch firth) internal processes such as the cycling of nutrient elements between dissolved and particulate phases, were important when estimating riverine nutrient fluxes to the coastal zone. On a regional basis, gross nutrient inputs were dominated by the pattern of freshwater flow rather than by high concentrations in individual rivers, the Tay being quantitatively the most important riverine source of nutrients to Scottish North sea coastal water. The possible implications of the nitrogen:phosphorus ratio at high salinity to phytoplankton growth in coastal waters are discussed. There are 50 references. **U.K.**

95-1112

**A methodology for the estimation of unit nutrient and organic loads from domestic and non-domestic sources.**

G. ANDREOTTOLA (Universita di Trento), L. BONOMO, L. POGGIALLI, and C. ZAFFARONI

*European Water Pollution Control*, 1994, **4**, No 6, 13-19

Unit pollutant loads were obtained for domestic and non-domestic sources by a simple mass balance. Knowledge of the population served, average daily pollutant concentrations and influent flow rates were required. The total pollutant load was separated into the domestic and non-domestic population equivalent loads by an iterative procedure. This methodology was applied to 2 areas of Italy and confirmed typical domestic values of BOD, COD and nitrogen loads per person of 60, 120 and 10 g per d respectively. However, values for phosphorus of 1.7 g per person d were lower than those generally used for planning purposes. These reflected changes in detergent formulations. Non domestic loads fluctuated widely around the averages, COD values were generally higher than domestic loads, those for phosphorus were approximately half, and they were comparable for nitrogen. **Italy**

95-1113

**MANS (Management Analysis of the North sea) method to determine nutrient loads to surface waters.**

P. S. GRASHOFF (WIL), E. W. RUDIGH, and J. W. PULLES  
*H2O*, 1994, **27**, No 25, 746, 747 and 745 (in Dutch-English summary p 727)

The construction, calibration and application of a computer model designed to forecast the effects of a Dutch national programme of fertilizer use reduction on surface water nutrient concentrations are described. The model integrated pre-existing models for predicting the values of nitrogen and phosphorus in waters, over time, with various degrees of restriction on their land application. The model's predictions are carried forward for 40 years. Assuming that the provisions of the Soil Protection Law were implemented in full, nitrate loads should halve within 20 years, but no early reduction in phosphorus loads were to be expected, whatever the severity of restriction adopted. (English translation 105 pounds sterling, valid for 1995). **Netherlands**

95-1114

**The effects of nutrient addition and pH manipulation in bag experiments on the phytoplankton of a small acidic lake in West Virginia, USA.**

E. A. P. AVALLIOS (West Virginia University, Morgantown), J. DeCOSTA, and K. E. HAVENS

*Hydrobiologia*, 1994, **291**, No 2, 93-103

The responses of phytoplankton to phosphorus, nitrogen, phosphorus plus nitrogen and/or base addition was investigated using *in situ* bag experiments. Increasing the pH from below 4.5 to above 6.3 caused phytoplankton biovolume to decline and give a succession from dino flagellates (*Petidinum microspicuum*) to small chlorophytes. The trend was more rapid where phosphorus additions were made along with pH enhancement. In summer there was phosphorus limitation, and nitrogen limitation in autumn, nutrient addition in both seasons greatly altering the phytoplankton composition in high pH treatments. At low pH, phosphorus addition during autumn followed by nitrogen addition caused dramatic changes in phytoplankton composition. **U.S.A.**

95-1115

**ENCORE: the effect of nutrient enrichment on coral reefs. 1. Experimental design and research programme.**

A. W. D. LARKUM (Sydney University, N.S.W.) and A. D. I. STEVEN

*Marine Pollution Bulletin*, 1994, 29, No 1/3, 112-120

Aspects of ENCORE, an *in situ* reef fertilization experiment are described in detail. Coordinated by the Great Barrier Reef Marine Park Authority the project would investigate responses from the cellular to community level. Microatolls were being subjected to enhanced nitrogen and phosphorus concentrations at 10 and 2  $\mu\text{M}$  respectively separately and combined for 2 years. Dosing was carried out automatically twice daily at low tides. The research programme consisted of 4 interlocking programmes addressing organism level responses to nutrient enrichment, the consequences for population and community structure, the regulation of nutrient supply, and the production of a model of nutrient effects. The whole project would create a database and model, foster scientific and management education in this area, support coral reef management and provide the basis of further studies. There are 56 references. **Australia**

95-1116

**Nitrogen and phosphorus in water as related to environmental setting in Nebraska**

J. O. HILGESON (U.S. Geological Survey, Lawrence, Kans.), R. B. ZIEGLER and J. K. STAMER

*Water Resources Bulletin*, 1994, 30, No 5, 809-822

The regional spatial distribution of nitrogen and phosphorus in water of the Central Nebraska basins, U.S.A., was characterized on the basis of environmental setting (Sandhills, Loess hills, Glaciated Area and Platte valley). Croplands dominated in the Glaciated Area and Platte valley. Rangeland dominated in the Sandhills. Groundwater data for 1978-1990 and streamwater data for 1981-1990 were used in the evaluation. Statistically significant differences in nitrate concentrations in both groundwater and streamwater samples were related to regional distributions of cropland and rangeland. Nitrate concentrations were larger in cropland, with associated fertilizer use, than in rangeland. In the cropland, nitrate concentrations were significantly larger in samples from shallow groundwater than in samples from deep groundwater. Largest phosphorus concentrations occurred in Sandhills where conditions were least favourable for sorption and chemical precipitation of phosphorus. Nitrogen and phosphorus concentrations in the Platte river reflected the quality of water entering the study area from upstream and limited base flow contributions from the Platte valley itself. **U.S.A.**

95-1117

**Decline in total phosphorus in the surface waters of lakes during summer stratification, and its relationship to size distribution of particles and sediments**

M. GUY (Waterloo University, Ont.), W. D. TAYLOR and J. C. HECHTER

*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No 6, 1330-1337

During stratification, the decline in total phosphorus in the surface waters of 40 oligotrophic to mesotrophic lakes varied between 0 and 59 per cent. The relationship between this decline and sedimentation was investigated in the case of 4 of the lakes. A positive correlation was observed. Lakes with larger particles showed larger declines in particulate phosphorus than lakes with smaller plankton, though declines in total phosphorus were not significantly related to particle size. The results suggested that sedimentation played a major role in

the decline in total phosphorus during stratification and was affected by the plankton community structure. There are 37 references. **Canada**

95-1118

**Modelling phosphorus trapping in wetlands using generalized additive models.**

K. H. RECKHOW (Duke University, Durham, N.C.) and S. S. QIAN

*Water Resources Research*, 1994, 30, No 11, 3105-3114

Simple statistical models were developed for the prediction of phosphorus trapping in wetlands. The work included an analysis of 2 data sets: a detailed database on trapping in a single natural wetland in south Florida, and a large cross-sectional database on nutrient trapping in North American wetlands. Statistical modelling was undertaken using a generalized additive approach. This approach relied on visualization, bivariate smoothing and additive functions. Phosphorus trapping was predictable using a simple function of phosphorus input and water loading. A nonlinear model was suggested for general application. There are 30 references. **U.S.A.**

95-1119

**Phosphorus general load on water ecosystems: assessment by simulation phosphorus model**

A. V. ILONOV (Scientific Coordinative Centre, Caspy, Moscow)

*Water Science & Technology*, 1994, 30, No 2, 81-89

The role of phosphorus in water bodies was simulated by a previously published model which expressed the concentration variability of phosphorus compounds through considering the chemical and biological influences on all forms of phosphorus in solution: in phytoplankton, zooplankton, bacteria, protozoa and detritus. Inputs to the model included water and wind regime information, temperature, radiation from the water surface, concentrations of the various forms of phosphorus, rates of phosphorus release from bottom sediments, and phosphorus inputs from external dispersed sources. The model was applied to several water bodies. Analysis of the combined simulation data allowed an estimate of phosphorus changeability and its general load, taking into account external phosphorus input plus an internal phosphorus cycling in the water ecosystem. **Russia**

95-1120

**Simulation of nitrification and denitrification processes in a tidal river**

T. KUSUDA (Kyushu University, Fukuoka), T. U. TAWATARI and K. OISHI

*Water Science & Technology*, 1994, 30, No 3, 43-52

The behaviour of nitrogen compounds in an adequately mixed tidal river in Japan was simulated in a model composed of hydraulic dispersion, suspended solids transport and nitrogen mass conservation sub-models. The last explained in detail, used a Lagrangian reference frame, which travelled upstream and downstream on a river with the mean water body, to reduce numerical dispersion on computation. Sediments, suspended solids and overlying water were taken as elements. The model was based on long-term field observations and its parameters were obtained from the literature and laboratory tests. Nitrification and denitrification were simulated, the rate of the latter being taken as a function of dissolved oxygen and nitrate concentrations. The results indicated that nitrification rate depended on the concentration of suspended solids and increased during spring



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udes. The denitrification rate, limited by the flux of nitrate to sediments, rose as sediment surface increased. Japan

95-1121

**Probabilistic methods for uncertainty analysis and parameter estimation for dissolved oxygen models.**

I. MASLJEV (International Institute for Applied Systems Analysis, Luxembourg), and L. SOMLYÓDY  
*Water Science & Technology*, 1994, 30, No 2, 99-108

Two probabilistic water quality models are considered: the Hornberger-Spear-Young (HSY) procedure with Monte Carlo simulation, and a Bayesian approach. Both were applied solely for the traditional Streeter-Phelps model and its extensions. The HSY approach was robust with a generic methodology to account for uncertainties. The Bayesian method had several promising features for linear systems. Its results deviated systematically from those of the HSY procedure. When applied to the Nitra river, Slovakia, the BOD decay rate obtained was high because of partially treated wastewater and shallow water. Streeter-Phelps parameters were consistent with literature values. Alternative dissolved oxygen models with 2-3 state variables and 2-5 parameters could also be calibrated to the data set. Probability density function ranges were broad, requiring a water quality management model to be carefully formulated. Austria

95-1122

**Carbonate mud in Mataiva Atoll, French Polynesia: suspension and export.**

B. WOJANSKI (Austrian Institute of Marine Science, Townsville, Qld, Australia), B. DELLISALLE, and R. GIBBS  
*Marine Pollution Bulletin*, 1994, 29, No 1/3, 36-41

The behaviour of carbonate mud in the Mataiva Atoll was investigated from vertical profiles of temperature, salinity and light transmissivity on a transect across the lagoon and at its outflow zone. Particle composition and size of unconsolidated mud were examined. Centrifuged solids and interstitial water were chemically analysed. Stream gauging and water level data indicated a water residence time of 73 d. Large quantities of mud were found in suspensions, concentrations reaching 80 mg per litre. The carbonate particles, arising from the re-suspension of abraded carbonate of biological origin, were exported offshore in a plume which lost buoyancy and sank through evaporative cooling. This observation suggested that contaminated mine water would also sink if released at a suitable point offshore. Polynesia

95-1123

**Trends in the quality of groundwater in Bahrain with respect to salinity, 1941-1992.**

W. K. ZUBARI (Arabian Gulf University, Manama), I. M. MADANY, S. S. AL-JUNAID, and S. AL-MANAI  
*Environment International*, 1994, 20, No 6, 739-746

Routine salinity data on wells and springs, salinity surveys and records of drilled wells were analysed by computer to discern changes over time. Salinity was generally above 2 g per litre; about 33 per cent of well water had a total dissolved solids content exceeding 4 g per litre while none had reached this value in 1975. The decline in quality began around 1960. Seawater intrusion was greatest in the eastern regions, and saline upflow occurred principally in the north-central area. The best quality water was in the north-western areas when the aquifer was recharged from Saudi Arabia by underflow. The decline was a typical result of over-exploitation. Bahrain

95-1124

**Concentration variations in rain and canopy throughfall collected sequentially during individual rain events.**

K. HANSEN (Danish Forest and Landscape Research Institute, Lyngby, Denmark), G. P. J. DRAAIJERS, W. P. M. F. IVENS, P. GUNDERSEN, and N. F. M. van LEEUWEN  
*Atmospheric Environment*, 1994, 28, No 20, 3195-3205

Canopy throughfall and precipitation were sampled sequentially through individual rain events in a Norway spruce (*Picea abies*) stand at Klosterhede, Denmark, and a Douglas-fir (*Pseudotsuga menziesii*) stand at Speuld, The Netherlands. Highest concentrations of sodium, chloride, magnesium, calcium, sulphate and nitrate ions were determined in the initial fractions of rain events and most deposition occurred in the first 2 mm; several maxima were observed for potassium and ammonium concentrations. At Speuld throughfall ionic concentration increased slightly at the beginning of most events, then decreased steadily and finally increased again at the end of the event. There was no consistent pattern at Klosterhede where the throughfall ionic concentration decreased, remained constant or increased throughout different events. Throughfall ionic concentrations were inversely correlated with rain intensity at both sites and were always higher than simultaneously collected rainwater concentrations indicating an apparently inexhaustible source of ions in the canopy. The processes involved in dry deposition, washoff and canopy exchange appeared to be extremely slow. There are 42 references. Europe

95-1125

**Monitoring changes in Greater Yellowstone lake water quality following the 1988 wildfires.**

R. G. LATHROP (Rutgers University, New Brunswick, N.J.), J. D. VANDERCASTLE, and J. A. BRASS  
*Geocarto International*, 1994, 9, No 3, 49-57

The effects of the 1988 fires on water quality in the Greater Yellowstone area were investigated by satellite remote sensing and the U.S. Geological Survey's water quality sampling. The large oligotrophic lakes were examined before and after the event by the Landsat Thematic Mapper and NOAA Advanced Very High Resolution Radiometer. These techniques revealed suspended sediment, phytoplankton pigment or dissolved organic material concentrations and water temperature. They put *in situ* samples into context and complemented conventional sampling and analysis. The fires appeared to have had no effect on the water quality of the Yellowstone lake with any nutrient influx minimal in comparison with natural inputs. The spring influx of suspended sediment to Jackson Lake was greater in the 2 years after the fires compared with previously and long-term trends were being studied. U.S.A.

95-1126

**Non-point-source pollution from interrill flow areas.**

A. PARR (Kansas University, Lawrence), S. LIMBACK, B. McENROE, and S. ZOU  
*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 6, 1056-1066

A method for estimating the total pollution mass from an agricultural field due to the uptake of interstitial water in the interrill flow region involved successive applications of a flow model and a mass transport model. Depth and velocity distributions in the longitudinally uniform interrill flow domain were obtained with the Limback 2-dimensional interrill flow model and used as input for the mass transport model which was a modified diffusion model. Empirical equations were employed to express dispersion coefficients as over-

land flow and soil parameter functions and an application example is presented. The 2-dimensional intertidal flow model could also be used in conjunction with other mass transport models including different physical processes. U.S.A.

95-1127

**Contaminants in seawater around England and Wales: results from monitoring surveys, 1990-1992.**

R. J. LAW (Ministry of Agriculture, Fisheries and Food, Burnham on Crouch), M. J. WALDOCK, C. R. ALLCHIN, R. F. LASLETT, and K. J. BAILEY

*Marine Pollution Bulletin* 1994, 28, No 11, 668-675

Seawater samples taken from estuarine, coastal and offshore sites were analysed for total hydrocarbons, hexachlorocyclohexanes, triazine herbicides, organotin compounds and various trace metals. The highest concentrations of all substances were found in estuaries, but not all estuarine values were high. Concentrations generally decreased rapidly with distance from the coast. For each metal the highest value was seen in one of the industrialized estuaries, and for copper, zinc, nickel and lead the concentrations were at least of the same order of magnitude as the Environmental Quality Standard (EQS). Most of the estuarine results for tributyltin exceeded the EQS of 2 ng per litre. Some lindane results from the Tyne and Mersey estuaries exceeded the 10 ng per litre concentration below which there is unlikely to be any threat to most marine species. U.K.

95-1128

**Recovery of the marine bottom environment of a Japanese bay**

N. UEDA (Kitakyushu City Institute of Environmental Sciences), H. TSUTSUMI, M. YAMADA, R. TAKEUCHI, and K. KIDO

*Marine Pollution Bulletin* 1994, 28, No 11, 676-682

Dokai Bay, adjacent to Kitakyushu, a city of more than 1 million inhabitants, was severely contaminated by industrial effluents and untreated sewage earlier this century. By the 1960s there was an apparent absence of aquatic organisms. Since 1970 the polluted bottom sediments have been dredged and effluent and wastewater treatment has been introduced. The chemical condition of water and sediment, and the abundance and composition of benthic communities was measured at 13 sites in May and August 1990. Heavy metal pollution had decreased greatly compared with pre-dredging concentrations. Organic pollution was high in the inner part of the bay, with COD there between 32 and 43 mg per g, which was higher than in 1968. Benthic organisms were abundant at all stations in May, with the highest densities in the inner and central areas. In August, the densities in these areas dropped sharply, but there was little change in the outer bay. To prevent this seasonal disappearance of organisms, the very high loading of nutrient salts must be reduced to control eutrophication. Japan

95-1129

**Heavy metals and petroleum hydrocarbons in nearshore areas of Tobago, West Indies**

W. RAJKUMAR (Institute of Marine Affairs, Chaguaramas, Trinidad) and D. PERSAD

*Marine Pollution Bulletin* 1994, 28, No 11, 701-703

Sediment and seawater samples were collected from around the island of Tobago and analysed for heavy metals and petroleum hydrocarbons. Heavy metal concentrations showed wide temporal variations at all sites. Total concentrations of dissolved heavy metals were generally higher in the wet months than the dry. Dissolved or dispersed petroleum hydrocarbon concentrations were higher and

less variable in dry season conditions than in wet, and exceeded those reported for the wider Caribbean. Absorbed and adsorbed hydrocarbon concentrations were higher on the windward side of the island than the leeward. Tobago

95-1130

**A strategy for monitoring the impacts of combined sewer overflows on the Ohio river.**

A. H. VICORY (Ohio River Valley Water Sanitation Commission, Cincinnati) and P. A. TENNANT

*Water Science & Technology* 1994, 30, No 1, 167-175

The U.S. EPA combined sewer overflow (CSO) control strategy is outlined. The policy used the attainment of water quality standards as the objectives for CSO control. In 1992 the Ohio River Valley Water Sanitation Commission (ORSANCO) established a working group to determine its role in abatement of pollution from CSO. Following a workshop in 1993, a strategy was developed with the following objectives: to identify appropriate monitoring and assessment approaches to address the impacts of wet weather discharges on the Ohio and other large rivers; to determine the impacts of CSO on Ohio river water quality; to determine the adequacy of the 9 minimal CSO controls in meeting water quality standards on the Ohio river and its tributaries; and to provide documentation of water quality improvements resulting from CSO controls. The responsibilities of CSO dischargers, state agencies, and ORSANCO are outlined. Technical considerations relating to water column sampling, bottom sediments, biological approaches, and modelling are discussed. U.S.A.

95-1131

**Urban impacts on microbiological pollution of the St. Clair river in Sarnia, Ontario**

J. MARSALEK (National Water Research Institute, Burlington, Ont.), B. J. DUTKA, and E. K. TSANIS

*Water Science & Technology* 1994, 30, No 1, 177-184

Urban impacts on faecal bacterial pollution of the near shore zone of the St. Clair river in Sarnia, Ont., Canada, were studied using field observations and computer modelling. Water samples were analysed for faecal coliform, faecal streptococci, *Escherichia coli*, *Pseudomonas aeruginosa* and coliphage densities. Microbial densities were processed by calculating geometric means, and the corresponding probabilistic distributions. High bacterial densities on the Sarnia waterfront, even during dry weather, suggested dry weather discharges of sewage along the waterfront. In dry weather, faecal coliform and *E. coli* densities downstream of the city exceeded those upstream from the city by an order of magnitude. Sources of bacterial pollution included sewage treatment plant effluents, dry weather discharges from both storm and combined sewers, and possible after effects of wet weather bacterial contamination. The distributions indicated significant probabilities of violation of a recreational guideline defined as 100 *E. coli* per 100 ml. Remedial measures to increase the probability of compliance were modelled. Microbiological quality in Sarnia bay could be improved by redirection of 2 storm sewer outfalls and the use of a barrier preventing the influx of faecal pollution along the east bay shore. Canada

## WATER QUALITY

95-1132

**Acidification and critical loads in surface waters. Kola, northern Russia.**

I. MOISEENKO (Institute of Northern Industrial Ecology Problems, Fersman, Russia)

*Ambio* 1994, 23, No 7, 418-424

Surface waters of the subarctic northern Kola territory were sensitive to acidification. Three hundred and seventy small lakes were surveyed. Daily observations of water quality variations in the flood period were made for 3 streams, 30-40 km south of a large nickel smelter. Anthropogenic influx of sulphates was the primary factor influencing water acidification. In the industrial regions with a high sulphate content, natural factors and dust emissions caused the buffering capacity of most lakes to be high. Mountain rivers were the most vulnerable to anthropogenic acidification. Sulphur critical loads were exceeded for 48 per cent of the lakes examined. There are 40 references. **Europe**

95-1133

**Atmospheric pollutants and their influence on acidification of rain water at an industrial location on the west coast of India**

I. T. KHEPMANI (Indian Institute of Tropical Meteorology, Pune), G. A. MOMIN, P. S. P. RAO, A. G. PHILLAI, P. D. SAIK, K. MOHAN, and M. G. RAO

*Atmospheric Environment* 1994, 28, No 19, 3145-3154

Rain water samples, collected at 11 locations in the Bombay region during the 1990 southwest monsoon season, were analysed for major anions and cations. Atmospheric aerosols and their size distribution were examined by a multi-stage Andersen sampler during August 1990. The deposition of the common ionic components of natural origin was uniform throughout the region. The concentrations of sulphur dioxide and nitrogen dioxide from industries were low and confined to within a few km of their source. Ammonia released from a fertilizer plant and natural calcium ion concentrations neutralized the acidic gases. In the 1970s the rain had been acidic; the change was ascribed to pollution control measures and the reduction in the use of coal. **India**

95-1134

**Channel catfish pond effluents**

M. F. SCHWARTZ (Auburn University, Ala.) and C. E. BOYD

*Progressive Fish Culturist* 1994, 56, No 4, 273-281

Water samples taken 4 times a year for 2 years from the surface and bottom of 25 ponds used for commercial culture of *L. tatarus punctatus* showed the following variables: BOD<sub>5</sub> 1.9-35.54 mg per litre, settleable solids 0.1-8 ml per litre, suspended solids 5.2-336.7 mg per litre, volatile solids 0.02-221.0 mg per litre, total phosphorus 0.1-85 mg per litre, soluble reactive phosphorus 0-0.074 mg per litre, total Kjeldahl nitrogen 0.58-14.04 mg per litre, total ammonia nitrogen 0.008-8.071 mg per litre, nitrite nitrogen 0.001-1.410 mg per litre, nitrate nitrogen 0.6-661 mg per litre, dissolved oxygen 0.8-16.8 mg per litre and pH 4.9-9.5. The frequency distributions and cumulative percentiles of these variables are presented. Concentrations of suspended solids and total phosphorus in this study often exceeded recommended effluent concentration limits. **U.S.A.**

95-1135

**Monte Carlo modelling of water and sediment contamination by toxic metals at the North Avenue dam, Milwaukee, WI, USA.**

V. NOVOTNY (Marquette University, Milwaukee, Wis.), L. FLIZHOU, and W. G. WAWRZYN

*Water Science & Technology* 1994, 30, No 2, 109-119

Water and sediment qualities of a reach of the Milwaukee river were simulated by a deterministic sediment-water quality model. The sediments were contaminated by heavy metals and other priority pollutants. The input of daily flows, concentrations, parameters and coefficients were subject to statistical analysis then entered a water quality simulation model through a Monte Carlo interface. The model was composed of 3 sequential segments, each represented by 3 systems: water, upper sediment and lower sediment layers. The mass balance of the sediment contaminants was strongly affected by the direction of groundwater fluxes through the sediments. The water column and the upper sediment layer were treated as in a steady-state while a dynamic mass model applied to the lower sediment layer. The inputs of the Monte Carlo simulation were 10 years long time series of upstream flows and combined sewer overflows. The calculated output concentrations were statistically similar to the probability distribution of measured concentrations. **U.S.A.**

95-1136

**Trace elements in atmospheric precipitation at Norwegian background stations (1989-1990) measured by ICP-MS**

T. BERG (Norwegian Institute for Air Research, Kjeller), O. ROYSE, and E. SITTENES

*Atmospheric Environment* 1994, 28, No 21, 3519-3536

Precipitation samples were collected weekly from 2 stations in the north east and 4 stations in the south of Norway in bulk collectors from February 1989 to December 1990. Trace elements were measured by inductively coupled plasma mass spectrometry (ICP-MS). Results were examined by non-parametric statistics. Element enrichment factors were calculated based on crustal iron. In the north east copper, nickel, cobalt and arsenic were the elements in highest concentrations associated with anthropogenic activity. In the south vanadium, lead, nickel, copper, zinc, arsenic, molybdenum and antimony were in this category. This was thought to originate from the industry of the Kola peninsula, Russia, and to long range atmospheric transport from Europe. Studies of back trajectories indicated that, in one example, air from the Sahara had passed over central Europe before reaching Norway. Wet deposition in the 48 h event had contributed 10-20 per cent of the annual wet deposition of most elements. In the south, wet deposition had much higher ratios to iron for the sea salt elements than had aerosols; the anthropogenic element ratios to iron were similar for both. There are 47 references. **Norway**

95-1137

**Pollution of urban runoff waters by heavy metals. Part I: total metal**

M. B. LARACAZENAVE (CURS, Paris), V. LUYA, A. CASTELBON, M. POINTEAUX, H. M. ASTRUC, and J. ALBERT

*Environmental Technology* 1994, 15, No 12, 1135-1147 (in French, English summary)

Stormwater was sampled sequentially during 7 major rainfall events in an urban residential area during 1 year. Analysis for cadmium, copper, lead and zinc showed that metals in the dissolved phase did not present a serious pollution problem but a minor first flush effect.

was observed. Concentrations of 5 ug cadmium per g, 400 ug copper per g, 700 ug lead per g and 2000 ug zinc per g were recorded in the particulate phase although there was no industrial activity or major road system in the study area. Factorial analysis showed strong correlations between suspended solids, COD, BOD5 and particulate copper and lead but no correlation between conductivity and other parameters (see also following abstract). (English translation 365 pounds sterling, valid for 1995) **France**

95-1138

**Pollution of urban runoff waters by heavy metals. Part II: speciation.**

M. B. LARA-CAZENAVE (CURS, Pau), A. CASTETBON, M. POTIN-GAUTIER and M. ASTRUC

*Environmental Technology*, 1994, 15, No 12, 1149-1159 (in French, English summary)

A speciation scheme is presented for determining 3 fractions of dissolved and particulate metals in stormwater collected by sequential sampling in an urban residential area during 7 major rainfall events in 1 year. In the dissolved phase most cadmium occurred in mobile or exchangeable fractions, copper formed stable complexes and was generally associated with carbonates and iron and manganese oxides and hydroxides, and the lability of zinc varied with the concentrations of suspended solids. In the particulate phase 59 per cent of cadmium occurred in the exchangeable fraction, 75 per cent of copper in the residual fraction and 50 and 31 per cent of lead in the residual and exchangeable fractions, respectively, while particulate zinc was divided between all fractions. Cadmium was the most mobile metal (see also preceding abstract). (English translation 255 pounds sterling, valid for 1995) **France**

95-1139

**Heavy metal pollution related to the infiltration of runoff water in a pervious road construction.**

M. EL GRIFF (Laboratoire Central des Ponts et Chaussées, Bouguenais), V. COUANDINI, D. DE MARE, J. D. BALADES and H. MADIEC

*Environmental Technology*, 1994, 15, No 12, 1185-1191 (in French, English summary)

Heavy metal contamination was investigated at a car park site with a porous asphalt surface where a retention basin with a porous base enabled on site infiltration of storm water. Suspended matter in samples of runoff contained high metal concentrations and the asphalt and soil near the infiltration pipes were contaminated with cad, copper, cadmium and zinc. The asphalt appeared to filter out and accumulate metals associated with suspended particles and there was no evidence of heavy metal contamination in the underlying soil. Tests to evaluate long term metal mobility indicated that the risks of metal release were very limited in the presence of deicing salts but more serious in the presence of exchangeable ions, complexing agents or acid solutions. Pollution risks could be minimized by regular pressure cleaning of the road surface and by intercepting suspended solids before entry into the infiltration pipes. (English translation 205 pounds sterling, valid for 1995) **France**

95-1140

**Contamination of Suva Harbour, Fiji**

S. D. NAIDU (South Pacific University, Suva) and R. J. MORRISON

*Marine Pollution Bulletin*, 1994, 29, No 1/3, 126-130

Areas near a municipal waste disposal site and a lead acid battery factory in Suva, Fiji harbour were sampled for sediment. The man-

grove oyster (*Crassostrea mordax*) was collected at the former site, but no shellfish were found at the latter. Samples were acid digested before analysis of trace metals by atomic absorption spectrophotometry. Metal contamination occurred at both sites with movement away from the waste dump evident. The lead contents of sediments near the factory were 0.83-26.6 per cent, rendering this part of the harbour a hazardous site. Some restrictions had subsequently been placed on the factory's operation. **Fiji**

95-1141

**Total organic carbon in streamwater from four long-term monitored catchments in Norway**

E. LYDERSEN (Norwegian Institute for Water Research, Oslo) and A. HENRIKSEN

*Environment International*, 1994, 20, No 6, 713-729

Chemical data for 1986-1992 on the air, precipitation and streams in 4 catchments of different water input, acid rain and stream water TOC were examined. Flux, concentration and net charge (NC) of TOC were related by linear regression analysis to parameters in these media. Relations between concentration, NC of TOC and chemical compounds in precipitation and streams were often specific to a catchment. Climatic changes also influenced TOC levels. The concentrations of non-marine base cations and TOC were significantly correlated at all sites, while non-marine sulphate and non-marine base cation concentrations showed little relationship. This indicated the role of organic matter in weathering reactions. Total aluminium concentration and non-marine sulphate were better correlated than total aluminium and TOC concentrations. The NC of TOC was most affected by variations of levels of compounds in precipitation, notably sea salts, which exerted more influence on the parameter than hydrogen ion concentration. Only at one site was a positive correlation found between hydrogen ion concentration and TOC. Measured and calculated levels of organic aluminium did not agree, indicating the constants used in the calculations did not correspond with actual values. They exhibited larger variations between sites than the monthly variation at a single site. There are 54 references. **Norway**

95-1142

**Distribution of polycyclic aromatic hydrocarbons in the water column and sediments of a drinking water reservoir with respect to boating activity**

E. A. MASTRAN (Virginia Polytechnic Institute and State University, Blacksburg), A. M. DIETRICH, D. E. GALLAGHER and T. J. GRIZZARD

*Water Research*, 1994, 28, No 11, 2353-2366

Water and sediment samples were taken from a reservoir in June and October 1990 when boating activities were high and low, respectively. The reservoir was 1.3 miles long and only 0.2 miles wide. Samples were extracted and cleaned up prior to analysis of PAH by gas chromatography-mass spectrometry. Total PAH concentration contour plots and statistical analyses were undertaken. Total PAH levels below 4 ug per litre were found in the water column during boating activities and none in the absence of boats. Sediment concentrations were usually below 700 ug PAH per kg. PAH profiles in the water samples were typical of combustion and petrogenic origins, while those of the sediments were entirely explained by combustion. There was some evidence that urban runoff and atmospheric deposition were also contributors. Sediments from marinas tended to be higher in PAH than those from other parts of the reservoir. There are 37 references. **U.S.A.**

## WATER QUALITY

95-1143

### Hexachlorocyclohexanes in seawater in the English Channel 1989-1993, following the loss of *MV Perintis*.

R. J. LAW (Ministry of Agriculture, Fisheries and Food, Burnham on Crouch), and C. R. ALLCHIN

*Marine Pollution Bulletin*, 1994, 28, No 11, 704-706

When the *MV Perintis* sank in the English Channel 5.8 tonnes of lindane was lost. Since then seawater concentrations of *alpha* and *gamma* hexachlorocyclohexane (HCH) have been monitored annually. Immediately after the sinking concentrations of *gamma* HCH were between 0.1 and 4.0 ng per litre and subsequent determinations have found a maximum of 1.8 ng per litre. These are considered to be background concentrations from a variety of sources. A concentration of 100 ng per litre would indicate that lindane had been released and that action was required. U.K.

95-1144

### Atrazine in spring runoff as related to environmental setting in Nebraska, 1992

J. K. STAMER (U.S. Geological Survey, Lawrence, Kans.), R. B. SWANSON and P. R. JORDAN

*Water Resources Bulletin*, 1994, 30, No 5, 823-831

Atrazine concentrations were determined in water samples collected during spring runoff in May 1992 at 5 sites in the Central Nebraska basins, U.S.A. Atrazine concentrations increased with increasing streamflow but decreased at peak streamflow, possibly because of dilution, and then increased again shortly after peak streamflow occurred. Concentrations of atrazine were related to land cover and the associated amount of atrazine applied. Atrazine transport was related to size of contributing drainage area, quantity of atrazine applied, amount and spatial distribution of precipitation, and volume of streamflow. The management implications for public water supplies of large atrazine concentrations are discussed. U.S.A.

95-1145

### A model of the transfer of radioactivity from sea to land in sea spray

P. M. NIELIS (Edinburgh University), D. BRANFORD and M. H. UNSWORTH

*Atmospheric Environment*, 1994, 28, No 20, 3213-3223

An essentially 2-dimensional sea to land transfer (SALT) model involved simple analysis of the atmospheric dispersion and deposition of radioactive sea spray droplets produced from the surf zone along the west Cumbrian shoreline. Different sea spray collection techniques employed in previous investigations were simulated to obtain physically reliable parameter values and the model output was in good agreement with both long- and short-term experimental data. The SALT model could be used to predict the inland transfer of spray-borne pollutants including radioactivity and to estimate the subsequent radiation exposure of the local population. U.K.

95-1146

### The physico-chemical limnology of loch Lomond.

G. A. BEST (Clyde River Purification Board, Glasgow) and I. TRAILL

*Hydrobiologia*, 1994, 290, No 1/3, 29-37

The limnology and water quality of Lomond loch, the largest fresh water lake in Great Britain, are reviewed. The loch is divided into several distinct basins by geological structures. The northern part is narrow and deep, while the southern part is broad and shallow with a number of islands. The geology of the catchment and the quality of rivers flowing into the loch determine the water chemistry. Long

term monitoring suggests that the quality of the loch water is stable with a low nutrient content. The major rivers flowing into the loch are both of good quality. The loch is regarded as oligotrophic, though the southern area verges towards mesotrophic. U.K.

95-1147

### Presence and survival of *Staphylococcus aureus* in the coastal area of Split (Adriatic sea).

M. SOLIC (Institute of Oceanography and Fisheries, Split), and N. KRSTULOVIC

*Marine Pollution Bulletin*, 1994, 28, No 11, 696-700

The presence and survival of *Staphylococcus aureus*, and its relation to faecal pollution indicators was measured in water samples from 17 sites near Split. *S. aureus* was found in 52.7 per cent of samples and at all sites. High concentrations were found near outlets of untreated wastewater where there was a high correlation of faecal indicators. Concentrations were also high near crowded beaches less affected by wastewaters, where faecal indicator concentrations were lower. The higher *S. aureus* concentrations were due either to shedding by bathers or longer survival of *S. aureus* compared with faecal indicators. Solar radiation and temperature were the most important factors determining the survival of *S. aureus*. Croatia

95-1148

### Controlling the water quality pattern in the distribution network, a delayed action automatic purging device.

F. DE VOS (Compagnie Generale des Eaux) and M. MENIN

*Eau Industrie Nuisances*, 1994, No 175, 40-42 (in French, English summary)

The problem of maintaining an adequate chlorine residual at all points in the water distribution network of the Syndicat des Eaux d'Ile de France (SE DIF) was accentuated by the occurrence of long periods of low flow at premises such as schools and colleges, when consumption fell almost to zero during the summer vacation and temperatures were also above average during this period. To counteract this an automatic purging device was developed and tested by the Seta company. The action of this device was controlled by a valve actuated by an electric programmer. It was designed to open the valve at predetermined intervals for a set period of time to flush the system and enable water in which the residual chlorine had decayed while the system had been at a standstill to be discharged to waste. The rate of discharge could easily be adjusted within the range 10-15 m<sup>3</sup> per h as a function of the pressure in the network. (English translation 75 pounds sterling, valid for 1995). France

95-1149

### Investigations into the time of travel of drinking water in the distribution systems of the Gemeentewaterleidingen Amsterdam and the NV PWN Waterleidingbedrijf Noord-Holland

J. COHEN (Gemeentewaterleidingen Amsterdam) and W. F. KONJUNBERG

*H<sub>2</sub>O*, 1994, 27, No 24, 710-715 (in Dutch, English summary, p. 701)

The temporary closure for maintenance of the water softening facility which provided water to Gemeentewaterleidingen Amsterdam and afforded them an opportunity to check on the residence time of water in their mains by following the movement of a water of a quality different from normal. The companies already possessed models of their distribution systems and of the probable quality changes from input to points along them. Measurements were taken over a 3-d period at sampling points, generally pumping stations. pH and sodium levels were the parameters selected. Data are provided

to show the changes over time at any one sampling point, and differences between one sampling point and another. On the whole the predicted and measured values were in good agreement, but it is strongly recommended to other organizations considering modelling their systems that predictions should be checked by measurements (English translation 270 pounds sterling, valid for 1995).

Netherlands

95-1150

## Environmental effects of aluminium used in water treatment plants of Rio de Janeiro State, Brazil.

J. M. AZCUE (Universidade Federal do Rio de Janeiro), O. MALM, and W. C. PFEIFFER

*Water Pollution Research Journal of Canada* 1994, 29, No 4, 571-579

The aluminium concentration was determined in drinking water after conventional treatment by the 6 principal water treatment plants in Rio de Janeiro, Brazil. The treatment plants used surface water from the Paraíba do Sul Guandu river (PSR GR) system and treated it by coagulation and flocculation with aluminium sulphate, sedimentation, rapid sand filtration and chlorine disinfection. Total aluminium concentrations in sludge were relatively constant (20 mg per g) but there were differences in the aluminium concentrations present in the available fraction in the different treatment plants. The Volta Redonda and Guandu water treatment plants performed best. The treatment plants of Barra do Pirai and Resende were the worst performers with an aluminium average concentration in treated water of 600 µg per litre. Tap water aluminium levels in homes supplied by Barra do Pirai were 980 µg per litre. World Health Organization recommended aluminium levels for drinking water were 200 µg per litre. There are 30 references. **Brazil**

# MONITORING AND ANALYSIS OF WATER AND WASTES

See also Abstracts 95-1125, 95-1131, 95-1147, 95-1382, 95-1420, 95-1445, 95-1485, 95-1488, 95-1495, 95-1497, 95-1498, 95-1499

95-1151

## A fixed film bioassay for the detection micropollutants toxic to anaerobic sludges.

B. R. ERASIN (Cranfield University, Bedford), A. P. J. TURNER, and A. D. WHEATLEY

*Analytica Chimica Acta* 1994, 298, No 1, 1-10

A short-term acute toxicity bioassay system is described for testing the effects of new and potentially toxic compounds on anaerobic digestion processes, particularly in anaerobic sludges. The inocula were immobilized in a reactor with a support matrix to give a rapid response and allow testing of large volumes of dilute samples. Changes in methanogenic activity were used to monitor both the process and the performance of intoxicated inocula. The reduction in methane production by the bacteria was compared to the activity in the absence of test compounds and to the activity of a parallel control assay. The performance of the bioassay was tested with chlorinated solvents and heavy metals. Trichloroethane caused a 50 per cent reduction in methanogenic activity at 7 mg per litre assay. The performance of suspended and fixed biomass assays were compared. The suspended growth was 5 times more sensitive to trichloroethane. There was no clear inhibition by heavy metals even at the

highest concentration used (up to 750 mg copper per litre). Two commercial bioassay systems for monitoring wastewater streams Microtox and RODTOX, which are based on aerobic bacteria but which may be used to protect anaerobic sludge digesters from toxic events, were compared with the anaerobic sequential batch bioassay (ASBA) described here. The aerobic Microtox and RODTOX assays exhibited different toxicity values to heavy metals and chlorinated solvents than did ASBA. However, similar trends of toxicity were observed. There are 50 references. **U.K.**

95-1152

## Bi transformations of Aroclor 1242 in Hudson river test tube microcosms.

K. M. FISH (General Electric Corporate Research and Development, Schenectady, N.Y.) and J. M. PRINCIPLE  
*Applied and Environmental Microbiology* 1994, 60, No 12, 4289-4296

The environmental fate of Aroclor 1242 in Hudson river sediments was investigated by determining PCB transformation patterns in static, unamended microcosms kept in the dark at 22-25°C with overlying water as the only oxygen source. The appearance of distinct aerobic and anaerobic zones after 2-4 weeks indicated the PCB would be anaerobically dechlorinated in subsurface sediments and oxidatively degraded in surface sediments. In subsurface sediment there was no decrease in total PCB concentration but changes in congener distribution resulted in a decrease in the average number of chlorine atoms per biphenyl from 3.11 to 1.84 in 140 d. A decrease in the total PCB concentration in surface sediment from 64.8 to 8.46 µmol per kg in 140 d together with changes in the PCB distribution indicated that congeners bearing meta chlorines were reductively dechlorinated while biodegradable congeners were attacked by aerobic PCB degrading microorganisms. Unamended microcosms provided a convenient, inexpensive method for assessing the fate of compounds released to river sediments. **U.S.A.**

95-1153

## Transformation of the herbicide diclofop-methyl in a large-scale physical aquifer model.

J. V. HEALDLEY (National Hydrology Research Institute, Saskatoon, Sask.), J. R. LAWRENCE, B. N. ZANYK, and P. W. BROOKS

*Water Pollution Research Journal of Canada* 1994, 29, No 4, 557-569

The transformation of diclofop-methyl was studied under isothermal 23°C steady-state conditions in a meso-scale physical aquifer model. A tank was filled with geological material to simulate C, Ap, B and surface horizons. Water was added to the system using a rotating sprinkler system. The transformations of diclofop-methyl were studied using GC with electron capture detection and GC/MS. The transformation products were generally similar to those previously reported in field experiments. The major differences were: (1) preferential formation of 4-(2,4-dichlorophenoxy)dehydrophenetole metabolite instead of the corresponding 4-(2,4-dichlorophenoxy)phenetole and the phenolic degradation product 4-(2,4-dichlorophenoxy)phenol, and (2) formation of chlorinated metabolites of benzoic acid formed in the presence of phthalate esters in the soils investigated. The polar chlorinated metabolites were predicted to be more mobile in the presence of water than the parent herbicide. **Canada**

## MONITORING AND ANALYSIS

95-1154

### Biodegradation of a s-triazine herbicides at low concentrations in surface waters.

S. J. FEAKIN (Kent University, Canterbury) E. BLACKBURN and R. G. BURNS

*Water Research*, 1994, 28, No 11, 2289-2296

Fourteen bacterial strains were isolated from industrial waste, agricultural soil, surface water or granular activated carbon (GAC) from water filters following enrichment in a minimal salts medium containing 5-10 mg per litre of both atrazine and simazine. The herbicides were extracted from water or solids by dichloromethane and analysed by gas chromatography after concentration steps. Biodegradation by isolates and non-inoculated controls of 1 µg per litre each of atrazine and simazine was assessed. Isolates from a wool scouring waste, a silt loam, and from a reservoir water degraded s-triazines at concentrations similar to those found in surface waters. The addition of GAC further enhanced degradation of the herbicides, probably because it provided surfaces for microbial growth. The presence of assimilable organic carbon assisted degradation. The introduction of suitable isolates to GAC adsorbers as a method of removing s-triazines during drinking water treatment was to be further explored. Detailed results are provided. There are 34 references. U.K.

95-1155

### Derivation of water quality objectives for hazardous substances to protect aquatic ecosystems: single-species test approach.

D. SCHULZ (Umweltbundesamt, Berlin)

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 263-272

Water quality objectives may be derived from toxicity tests on bacteria, algae, crustaceans and fish, where the lowest no-observed effect concentration (NOEC) for the most sensitive species is adjusted by a safety factor, usually 0.1. An alternative method uses a species sensitivity distribution and sets a maximal permissible concentration which will protect 95 per cent of the most sensitive species and a negligible concentration at 1 per cent of this. Comparing the methods using model NOEC data showed that when only 4 NOEC values are available a safety factor of 0.01 would be required to be 95 per cent certain of protecting 95 per cent of species. Even this will not protect the ecosystem if key species are among the other 5 per cent. To validate the extrapolation method, species sensitivity distribution for widely tested pollutants must be analysed.

Germany

95-1156

### Aquatic field studies in ecotoxicological assessment of hazardous substances.

C. KUSSATZ (Federal Environmental Agency, Berlin)

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 281-284

Multi-species field tests could be useful for extrapolating the results from single-species laboratory toxicology tests, but they need to use the same species and end points. They are no more useful than laboratory tests unless the tests reflect effects on the function and structure of communities. Minimal requirements for a useful field study are examination of several test concentrations and untreated controls, with the ability to derive the no-observed effect concentration, exposure of several taxonomic groups over a longer period, analytical control of the test concentration, the ability to repeat the

experiment under different starting conditions with controls and the use of aquatic ecological parameters as the toxicological endpoint. Germany

95-1157

### Cyst-based ecotoxicological tests using Anostracans: comparison of two species of *Streptocephalus*.

A. CRISINEL (Ecole Polytechnique Fédérale de Lausanne), L.

DELAUNAY, D. ROSSET, J. TARRADELLAS, H. MEYER, H. SAIAH, P. VOGEL, C. DELISLE, and C. BLAISE

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 317-326

Two Anostracan species, *Streptocephalus rubricaudatus* and *Streptocephalus texanus* were compared in toxicology tests against 16 pollutants. Standardized or commercial tests based on crustaceans, rotifers and bacteria were also performed. For heavy metals, the two *Streptocephalus* species were slightly more sensitive than *Daphnia magna* and much more than the marine *Artemia salina*. The sensitivity of all 4 Anostracan species to organic and organometallic micropollutants was of the same order of magnitude as *D. magna*. The sensitivity of *S. rubricaudatus* to organic solvents was low, but it was quite sensitive to sodium chloride and could only be used for freshwater samples. These cyst-based freshwater Anostracans could provide a low-cost alternative to *D. magna* tests, with similar sensitivity. There are 44 references. Switzerland

95-1158

### Comparative studies on cytotoxicity of micropollutants in water: principle of cytotoxicity matrix.

H. UTSUMI (Shoma University, Tokyo), K. KIYOSHIGE, S. SHIMBARA, and A. HAMADA

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 333-339

The cytotoxicities of a range of chemicals were measured using inhibition of colony formation of L-929 cells and membrane damage of liposomes. Some pesticides and chlorination by-products caused a dose-dependent inhibition of L-929 colony formation, but there was little effect on membrane permeability of liposomes. Comparison with results from tests using viability of HL-60 cells, phagocytic activity of mouse peritoneal macrophages, glycogenolysis and LDH release of rat liver hepatocytes showed a correlation ( $r$  equal to 0.65) between cytotoxicities to L-929 and HL-60 cell lines, but not between any other results. Cytotoxicity matrices were constructed for various chemicals using the results from different tests. Similar matrices were obtained from chemicals with similar structures. Bio-monitoring based on one test was not adequate to secure the safety of drinking water, and the cytotoxicity matrix might be useful in monitoring the effectiveness of water purification. Japan

95-1159

### Chemosensory responses of ciliates, a sensitive end point in xenobiotic hazard assessment.

W. PAULI (Freie Universität Berlin), S. BERGER, S. SCHMITZ, and L. JASKULKA

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 341-346

An assay using the chemosensory behaviour of ciliates was performed with *Tetrahymena thermophila*. A concentration-dependent avoidance response was seen for all 43 substances of the test battery. There were low correlations with results from toxicity tests on *Tetrahymena* growth and with recommended aquatic toxicity tests, suggesting that the chemosensory response reflects chemical inter-

actions not expressed by the standard tests. For more than half of the chemicals tested the chemosensory response was more sensitive than tests on fish or *Daphnia*. Germany

## 95-1160

**Denver potable water reuse demonstration project: comprehensive chronic rat study.**

L. W. CONDIE (U.S. Army Dugway Proving Ground, Utah), W. C. LAUER, G. W. WOLFE, E. T. CZEK, and J. M. BURNS  
*Food and Chemical Toxicology*, 1994, 32, No 11: 1021-1030.

The 1 million gpd water reuse treatment plant providing 500 fold concentrates of water treated by multiple processes to remove microbial and chemical contaminants was compared with Denver's present high-quality drinking water using Fischer 344 rats exposed to the complex mixture solutions for up to 2 years to evaluate chronic toxicity and oncogenicity effects. Clinical pathology, gross pathology and microscopic pathology at week 26 and 65 and at the end of the study (104 weeks) did not reveal any findings that were treatment related. The administration of drinking water concentrates at up to 500 times the original concentration to F-344 rats for 104 weeks did not result in any demonstrable toxicological or carcinogenic effects. U.S.A.

## 95-1161

**Metabolic fate and disposition of 2-acetylaminofluorene in rainbow trout, *Oncorhynchus mykiss*.**

A. R. STEWARD (New York State University, Buffalo), S. A. EL MARAKBY, R. MASLANKA, S. KUMAR, and H. C. SIKKA  
*Aquatic Toxicology*, 1994, 30, No 3: 225-236.

The metabolic fate of 2-acetylaminofluorene (AAF) was examined in Shasta strain of rainbow trout (*Oncorhynchus mykiss*). Unlike several mammalian species, Shasta trout were resistant to hepatocarcinogenesis by AAF. The trout was dosed orally with carbon-14 labelled AAF. AAF derivatives were rapidly eliminated from the liver and into the bile. Liver AAF radioactivity after 24 h was 25 per cent of that at 8 h. Bile radioactivity at 24 h contained 83 per cent of the radioactive dose. Of the radioactivity retained by the liver after 24 h, only 3.5 per cent represented unmetabolized AAF. AAF and 2-aminofluorene (AF) accounted for 3.3 per cent and 4.8 per cent, respectively, of bile radioactivity at 24 h. Glucuronide and sulphate conjugates accounted for 63 per cent and 12 per cent of bile radioactivity after 24 h, respectively. The metabolite  $N$ -OH-AAF, a potential carcinogen, was detected as the glucuronide conjugate and accounted for only 2 per cent of total bile radioactivity. The results indicated that the Shasta trout liver was highly efficient in the detoxification and elimination of AAF and its metabolites. U.S.A.

## 95-1162

**PCB concentration trends in lake Michigan coho (*Oncorhynchus kisutch*) and chinook salmon (*O. tshawytscha*).**

C. A. STOW (Wisconsin University, Madison), S. P. CARPENTER, and J. E. AMRHEIN  
*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No 6: 1384-1390.

PCB concentration data for coho (*Oncorhynchus kisutch*) and chinook salmon (*Oncorhynchus tshawytscha*) in Michigan Lake covering the period from 1974 to 1990 were examined. A generally decreasing pattern in both species was confirmed by the mean and variance of the concentrations. Three models, an exponential decay model, a double exponential decay model and an exponential decay model with a non-zero asymptote were fitted to the data. The double exponential decay model gave the best fit for both species. Rate

coefficients estimated for this model indicated a slowing of the initial rapid decrease in PCB levels. Levels might be showing a current increase due indirectly to the decline of the alewife (*Alosa pseudoharengus*) forage base during the 1980s. U.S.A.

## 95-1163

**Environmental effects on the distributions of groundfish in Hecate Strait, British Columbia.**

R. I. PERRY (Pacific Biological Station, Nanaimo, B.C.), M. STOCKER, and J. JARGO  
*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No 6: 1401-1409.

An objective method was used to identify associations of representative species of demersal fishes in Hecate Strait, B.C., with environmental conditions. The method was based on cumulative distribution functions. The factors studied were bottom depth, bottom temperature, and sediment type. The categories of species identified were those consistently associated with particular temperatures and depths, those with variable depth and temperature associations, and those with no apparent relationships to depth. Identification of significant associations between species and habitat was a step towards incorporating environmental data into survey abundance indices and reducing by-catch problems. Canada

## 95-1164

**Biomagnification of PCBs, *p,p'*-DDT, and HCB in the river Po ecosystem (northern Italy).**

S. GALASSI (National Research Council, Milan), I. GUZZETTA, M. BATTIGAZZORE, and A. CARRERI  
*Ecotoxicology and Environmental Safety*, 1994, 29, No 2: 174-186.  
Concentrations of total PCB and *p,p'*-DDT, on a dry weight basis, were highest in *Alburnus alburnus*, *Perca fluviatilis*, *Scardinius erythrophthalmus* and *Barbus barbus*, while for HCB the highest levels were found in *Leuciscus cephalus*, *A. alburnus* and *Rutilus rutilus*. Bioconcentration models used to test the equilibrium condition between biotic and abiotic compartments showed that the oligochaetes sediment model fitted with experimental results, the only exception being hexachlorobenzene. Fish species indicated that most PCB congeners and *p,p'*-DDT were biomagnified in the Po river ecosystem but to a lesser extent than expected on the basis of a 4-step food chain model. All fish species, except *P. fluviatilis* approached level 3 of the theoretical fugacity model. *P. fluviatilis* demonstrated higher values intermediate between levels 3 and 4. Italy.

## 95-1165

**Fish as indicators of ecological sustainability: historical sequences in Toronto area streams.**

G. A. WILHERD (Toronto University, Ont.)  
*Water Pollution Research Journal of Canada*, 1994, 29, No 4: 509-617.

A weighted species association tolerance index with respect to water quality (WSATI-WQ) was developed from the literature on the sensitivity of different species to certain types of changes in their habitats. The index was used to compare changes in ecological conditions at 12 sub-watersheds in the Toronto area watershed (TAW). Index scores for TAW sub-watersheds showed 6 representative patterns since the 1950s. The largest scores were associated with relatively undisturbed sites and the smaller scores with disturbed sites. Some stress from urbanization had been offset by benefits from improved management of sewage. There are 40 references. Canada



## MONITORING AND ANALYSIS

95-1166

### **Spectroscopic evaluation of interactions among trace elements and biogenic carbonates in the marine environment.**

P. RIVARO (Università di Genova University), R. FRACHEL, A. MAZZUCOTELLI, F. CARIATI and A. POZZI

*Analyst* 1994 119, No 11: 2485-2489

The interactive behaviour of manganese, copper, cobalt and cadmium with biogenic carbonates (marine mussel shells *Mytilus edulis*) in aqueous media was investigated using electrothermal atomic absorption spectrometry (ETAAS), inductively coupled plasma atomic emission spectrometry (ICP-AES) and electron paramagnetic resonance (EPR). Mussel shells were previously shown to consist of 2 layers: an outer prismatic calcite layer and an inner nacreous aragonite layer composed of organic material and calcium carbonate crystals. The spectroscopic results indicated that the trace metals did not form a distinct precipitated phase on the shell surfaces, but that they interacted with the calcium carbonate. Thus, absorption phenomena by the organic materials associated with the shells were ruled out. It was hoped that the shells of mussels would provide an alternative to soft tissue for trace metal analyses in biological monitoring programmes. There are 30 references. **Italy**

95-1167

### **Mixed function oxygenase system components and antioxidant enzymes in different marine bivalves: its relation with contaminant body burdens**

M. SOLÉ (Cid-CSIC), Barcelona), C. PORTE and J. ALBAIGES

*Aquatic Toxicology* 1994 30, No 3: 271-283

Tissue concentrations of PAH, PCB, DDT, hexachlorobenzene and lindane were measured in 4 marine bivalve species living in different habitats. The bivalves were the mussel *Mytilus galloprovincialis*, oyster *Ostrea edulis*, western oyster *Crassostrea gigas*, and the clam *Tapes semileucostata*. The presence and activities of the mixed function oxygenase (MFO) enzymes and anti-oxidant enzymes were examined for the same species. There was general correlation between tissue PAH accumulation and the content of cytochrome P450 and with the activities of NADPH cytochrome c reductase and microsomal NAD(P)H dependant DT diaphorase. There was some correlation between the accumulation of organochlorine compounds and glutathione peroxidase activity. There are 46 references. **Spain**

95-1168

### **Faecal coliform recovery in two standard media along an estuarine gradient.**

A. E. BORDALO (Oporto University, Porto)

*Water Research* 1994 28, No 11: 2331-2334

The recovery of faecal coliforms in m-FC agar and Lactose agar with TTC and Tergitol was investigated in waters ranging from clean freshwater to polluted seawater. Log transformed counts were compared by nested analysis of variance. Although results for some saline samples were different, there were no statistically significant differences in the performances of the media. *Escherichia coli* represented 82 per cent of typical colonies on average, with a range of 47-100 per cent. Thermosensitive *E. coli* accounted for less than 4 per cent of the total number of isolated bacteria. **Portugal**

95-1169

### **Bed-load sampling in sand-bed rivers.**

M. T. K. GAWLESH (Hydraulics and Sediment Research Institute, Delta Barrage) and L. C. van RIJN

*Journal of Hydraulic Engineering* 1994 120, No 12: 1364-1384

An attempt to measure the total-load transport in the Nile was made by Delft Hydraulics of The Netherlands and the Hydraulics and Sediment Research Institute of Egypt. A mechanical sampler was developed to measure the bed load and the suspended load simultaneously. After flume testing with different bed materials and flow velocities to define the sampling efficiency, field studies were undertaken in the Nile and Rhine rivers. The sampling efficiency factor was about 1.0 for bed material sizes larger than about 400 µm and about 1.5 for finer material sizes. The error of the mean transport rate at a sampling station was determined as a function of the number of samples. **Egypt**

95-1170

### **A field and laboratory procedure to collect, process, and preserve freshwater samples for dissolved organic carbon analysis**

*Limnology and Oceanography* 1994 39, No 6: 1470-1476

A procedure was developed for the collection, processing and preservation of freshwater samples for the determination of dissolved organic carbon (DOC). The protocol was devised for use in both field operations and in the laboratory. Sample collection utilized a portable manual syringe which drew the sample through a filter and into the syringe via a 3-way valve. The system provided filtered blanks of less than 5 µg carbon per litre. Data collected over 5 years indicated an average relative precision of 2 per cent for DOC determination from sample collection to persulphate oxidation. A cartridge system for filtration of 100 litre sample quantities gave similar precision. Samples stored with biocides or acids were stable at room temperature from periods of 2 weeks to 18 months with a reduction in accuracy of between 1 and 11 per cent. **USA**

95-1171

### **Global sites to document long term ecological changes using space shuttle earth observations photography database: Omo river delta, lake Turkana (Africa) as an example of the database application**

K. LULLA (NASA/Johnson Space Center, Houston, Tex, USA) and R. ALLISON

*Geocarto International* 1994 9, No 3: 67-68

Examples are given of the potential application of the Space Shuttle Earth Observations database for monitoring and modelling. Imagery of the Omo river delta showed it had increased by 400 per cent since 1965 and was continuing to grow. Ponds were being farmed. The method was valuable for studying tropical areas where detailed information was often lacking. **Africa**

95-1172

### **The use of remote sensing to study eutrophication, demonstrated in Friesland**

T. H. L. CLAASSEN (Waterschap Friesland, Leeuwarden), P. B. ROFFERS, H. BUTTEVELD and K. APPELMAN

*Hydro* 1994 27, No 25: 740-745 (in Dutch, English summary, p. 727)

Conventional monitoring of the lakes of Friesland, The Netherlands, for indicators of eutrophication (nitrogen, phosphorus, chlorophyll and Secchi disc transparency) had regularly revealed contravention of standards sought for surface water quality. Satellite images of the

area containing the lakes were analysed for their indications of chlorophyll, transparency, suspended matter and temperature, and compared with that by conventional monitoring. Some of the satellite images were good at reflecting the influences of the influx of water from the IJsselmeer and of wind. Some of these factors might have been missed by conventional methods, depending on the point of monitoring, but few satellite images were sufficiently clear to give an unequivocal picture of eutrophication and for such small water bodies, airborne remote sensing appeared preferable. (English translation 270 pounds sterling, valid for 1995) **Netherlands**

95-1173

**Monitoring process using wireless data acquisition.**  
S. CHEEK (Fluke Corporation, Everett, Wash.) and R. WILKES. *Water Engineering & Management*, 1994, 141, No 10, 17-18.  
The use of wireless data loggers to monitor wastewater treatment processes and systems is discussed. A wireless communication link between a data logger and a PC could avoid installation problems and provide the capability for a real time view and historical trend chart of the treatment process. The design, operation and performance of wireless data acquisition systems are described. Management of the measurement data is discussed. **U.S.A.**

95-1174

**BOD biosensor for secondary effluent from wastewater treatment plants.**  
H. TANAKA (Ministry of Construction, Ibaraki ken), E. NAKAMURA, Y. MINAMIYAMA, and T. TOYODA. *Water Science & Technology*, 1994, 30, No 4, 215-227.  
A sensor which measured BOD swiftly was developed with immobilized yeast, *Trichosporon cutaneum*, as receptor and a dissolved oxygen probe as transducer; these were separated by a Teflon membrane. The sensor was placed in a flow cell which received a mixture of sample and buffer. The probe accurately measured the soluble BOD in untreated domestic and other strong wastewaters. Its results were smaller than manually measured BOD<sub>5</sub> for specific organic compounds and much smaller for secondary effluents and river waters. Attempts to improve performance included using an artificial calibrating solution whose properties were close to those of secondary effluent and the immobilization of alternative organisms with polyvinyl alcohol. The most effective receptor was an unknown strain isolated from biofilm growing in an effluent from a sewage works. These modifications improved the performance of the sensor to within 10 per cent of the manual result. It was still unable to detect nitrifying and particulate BOD. **Japan**

95-1175

**Fluorescence monitoring of an alternating activated sludge process.**  
S. ISAACS (Denmark Technical University, Lyngby), and M. HENZE. *Water Science & Technology*, 1994, 30, No 4, 229-238.  
Intracellular nicotinamide adenine dinucleotide (phosphate) concentrations were monitored in an alternating activated sludge plant by irradiation at 340 nm and measurement of fluorescence at 460 nm. No maintenance of the sensor was required over 2 months. The fluorescence signal increased abruptly in the transition from anoxic to anaerobic conditions. It decreased slowly during aeration and increased slowly in the anoxic periods. Fluorescence could thus indicate the point when oxidized nitrogen was exhausted. There was weak correlation between the fluorescence baseline and the peak oxygen uptake rate which implied that the former was an indicator

of metabolic activity in the activated sludge process. In combination with other on-line measurements it could contribute to the assessment of activated sludge performance. **Denmark**

95-1176

**Central control and monitoring - more safety, lower costs.**  
F. GIERING (IB Grombach & Co. AG, Zurich). *Water Supply*, 1994, 12, No 3/4, 277-287.  
Methods for continuous central control and monitoring of outstations through remote and master control equipment are described. Modern units were modular and could network with other systems. Remote and control stations could communicate by dedicated signal cable, public telephone network, radio, or glass fibre cable. Central control reduced operating and maintenance costs through efficient use of energy and manpower. Safety and security were improved. Continuously reducing costs of the equipment enabled even small undertakings to use it with economic advantage. A common control room was particularly advantageous for organizations responsible for more than one utility. Various aspects of the systems are outlined. **Switzerland**

95-1177

**On line quality control in distribution networks.**  
B. NGUYEN (SAGEP, Paris) and A. MONTILLI. *Water Supply*, 1994, 12, No 3/4, 289-299.  
The Paris water distribution network, its management and monitoring are described. Flow, pressure and quality parameters from all parts of the network were continuously monitored at a control centre. 85 control valves and 11 pumping stations could be remotely operated. The 5 principal elements in water quality management, namely objectives, methodology, on line data tracking, and field equipment are discussed. The quality of service was closely monitored to assess progress. Particular attention was paid to the final chlorine level of 0.1 mg per litre; this had caused a new generation of chlorine monitors to be developed which would operate for 6 months without attention. Only about 200 complaints per year were received in the Paris region of 2 million inhabitants and 120 concerned private networks within buildings. Details of the control philosophy are provided. **France**

95-1178

**Automatic operation of the water distribution of the city of Paris.**  
B. NGUYEN (SAGEP, Paris). *Water Supply*, 1994, 12, No 3/4, 301-307.  
The management of the production and distribution of water in Paris is explained. A recently renovated control and command centre managed the whole system through storage volumes, water production, pressure control, the avoidance of stagnant areas, and coordination of zones. The new system seeks security, quality, economy, easy maintenance and user friendliness. Real time and off line processing systems are outlined. Hardware and software are listed. Further developments include widespread chlorine monitoring, amendments to the mathematical model and the introduction of a geographical information system. **France**

95-1179

## Implementing an integrated strategy for monitoring, control and decision support in Severn Trent Water.

M. F. WILLIAMS (Severn Trent Water Limited, Birmingham) *Water Supply* 1994, 12, No 3/4, 349-360

The business case methodology and the project management techniques to define, design and implement a telemetry system for the remote monitoring and control of 3500 installations are described. The preparation of the business case reviewed possible solutions, costs, interfaces with existing telemetry, control instrumentation and automation (ICA) systems, the implementation of proposals, and programming. Sample engineering audits of operational sites determined functionality, and existing investment in ICA and communications. Overall cost estimates were obtained by extrapolating with the aid of databases and financial modelling. User requirements were satisfied by design intent documents, presentations and demonstrations helped users to understand and accept the proposals. Implementation was speeded by using model specifications and standards. Close liaison on site between systems engineers and operations personnel enabled speedy, efficient and progressive completion. U.K.

95-1180

## Drinking-water quality monitoring and surveillance

M. SUGANAN PILLAY (Ministry of Health, Kuala Lumpur), M. I. SEIIM and D. SIRI *Waterlines* 1994, 13, No 2, 8-10

The importance of monitoring and surveillance of drinking water quality in preventative health policies is discussed. Issues to be considered in the planning and implementation of a successful monitoring and surveillance programme are described. The role of international organizations, national governments and local communities in this planning and implementation is examined. Experiences in Malaysia in setting up and operating a national drinking water quality surveillance programme are described. Benefits achieved from this programme are discussed. Malaysia

95-1181

## Correct operation of automatic sampling equipment for liquids.

C. SAMI (Hydrologic)

*Eau Industrie Nuisances* 1994, No 175, 28-30 (in French, English summary)

The automatic sampling of liquid effluent streams, whether composed of sewage or effluents, is an essential prerequisite for analytical purposes, either as a method of process control or for monitoring compliance with quality stipulations as a method of pollution control. While much attention has been devoted to the refinement of automatic analysers, the performance of the sampling device has often been overlooked. In recent years 2 alternative types of sampler have been developed: one employing a vacuum pump (usually of European manufacture) and the other based on a peristaltic pump (usually made in the U.S.A.). The principles of operation of these 2 types are described, including their susceptibility to errors. The design of F.P.C. sampling equipment conforming to the new international standard 5667-10 is described, together with some observations on its performance in use. For battery-powered sampling equipment, a battery should be fitted that has a sufficient working life, of a duration not less than the intervals between routine inspections of the equipment, and which can provide any desired number of samples during the same period. (English translation 65 pounds sterling, valid for 1995) France

95-1182

## Submersible, osmotically pumped analysers for continuous determination of nitrate *in situ*.

H. W. JANNASCH (Monterey Bay Aquarium Research Institute, Pacific Grove, Calif.), K. S. JOHNSON and C. M. SAKAMOTO *Analytical Chemistry* 1994, 66, No 20, 3352-3361

The results of a chemical analyser designed to operate while completely submerged for periods of 1 month or longer, used for the determination of dissolved nitrate are presented. The continuous flow analyser was powered by osmotic pumps driven by a sodium chloride gradient which propelled both sample and reagents through a miniature continuous flow manifold. The analyser operated with sample and reagent flow rates of about 1.2 and 1.1  $\mu$ l per h, respectively (approximately 8 and 0.7 ml per month) and showed a linear response for nitrate levels between 0 to 20  $\mu$ M with a detection limit of 0.1  $\mu$ M. The analyser had a 90 per cent response time of approximately 30 minutes. It was capable of automatically standardizing itself by correcting for baseline and sensitivity drift by periodically injecting and analysing known standard solutions. The system was adaptable to a variety of colorimetric analyses applied to various environmental, oceanographic and process control monitoring situations. U.S.A.

95-1183

## Photometric phosphorus determination in natural waters in the form of associate of phosphoric-molybdenum acid and brilliant green

A. I. PILIPENKO (A. V. Dumanskii Institute of Colloid Chemistry and the Chemistry of Water, Kiev), O. M. TROKHIMENKO and N. I. FALINDYSH

*Journal of Water Chemistry and Technology* 1994, 16, No 2, 7-11

A highly sensitive colorimetric determination of phosphorus is reported. Polyphosphates were converted to orthophosphate by acid hydrolysis at 90°C and reacted with brilliant green dye (BG) in the presence of ammonium molybdate. The resultant coloured solution was stabilized by the addition of the nonionic surfactant OP-10. The limit of detection was 3 to 5  $\mu$ g per litre with a relative standard deviation of 4 per cent. A method for the analysis of natural water samples is presented. Concentrations of bicarbonate, aluminium, calcium, potassium, nitrate, iron, cobalt, nickel, copper, zinc, magnesium, sodium, ammonium, chlorate, tungsten, arsenic and vanadium ions which did not interfere with the determination are given. Silicate at concentrations in excess of 0.0001 M gave positive errors, although large quantities of silicate could be removed by acid hydrolysis and filtration. Ukraine

95-1184

## Field-based heavy metal analyser for the simultaneous determination of multiple cations on-site.

G. WILLIAMS (Manchester Metropolitan University) and C. d. SILVA

*Analyst* 1994, 119, No 11, 2337-2341

A hand-held, battery-powered electroanalytical instrument, based on anodic stripping voltammetry (ASV), was designed for the simultaneous field determinations of copper(II), lead(II) and cadmium(II) in aqueous environmental samples, down to 10  $\mu$ g per litre, with an overall analysis time of 3 minutes. The instrument utilized baseline and peak correction, a glassy carbon working electrode, *in situ* plating and forced convection to achieve low detection limits. Sample pretreatment included the addition of a matrix-modifying electrolyte solution (1 ml) containing a mixture of hydrochloric acid and mercury(II) salt. The instrument was validated by testing in the field.

in an area of North Wales with a past history of heavy metal extraction and in domestic tap water samples. U.K.

95-1185

**Immobilized cyanobacteria for on-line trace metal enrichment by flow injection atomic absorption spectrometry**

A. MAQUIEIRA (Valencia University), H. A. M. ELMAHADI and R. PUCHADES

*Analytical Chemistry*, 1994, 66, No 21, 3632-3638

The performance of the covalent immobilization of cyanobacteria (*Spirulina platensis*) on controlled pore glass (CPG) was evaluated by examining the system's binding capabilities for trace metal (cadmium, copper, iron, lead and zinc) enrichment prior to on-line flow injection atomic absorption spectrometric (FIA-AAS) analysis. CPG was formed by phase separation of homogeneous borosilicate glass followed by dissociation of the boron-rich glass phase by strong acid, leaving a highly porous silica-rich glass. The FIA-AAS system ascertained that preconcentration of trace metals from aqueous solutions was obtained with high efficiency. The degree of metal binding was pH dependent. Copper, zinc and cadmium were quantitatively retained at a wide range of pH values, while lead and iron were adsorbed strongly only at pH 6 and pH 7, respectively. Breakthrough capacities, determined from breakthrough curves, were 0.0035, 0.0008, 0.0011, 0.0028, and 0.0017 mg per ml for copper, zinc, cadmium, lead and iron, respectively. This technique was validated by measurement of cadmium and copper in a certified reference sample (BCR No 144, sewage sludge). The binding columns retained their activity for 3 months with 6 h of continuous use per day. There are 32 references. Spain.

95-1186

**Determination of heavy metal interactions with dissolved organic materials in natural aquatic systems by coupling a high performance liquid chromatography system with an inductively coupled plasma mass spectrometer**

L. ROTTMANN (Universität Regensburg) and K. G. HEUMANN

*Analytical Chemistry*, 1994, 66, No 21, 3709-3715

An HPLC system with a size exclusion column was coupled with an ICP-MS detector for the determination of interactions between heavy metals and different fractions of dissolved organic matter (DOM) in natural waters. In this way, specific molecular size distribution patterns of DOM were identified. On-line isotope dilution mass spectrometry was used to quantify heavy metals accurately in different organic fractions. Different distribution patterns in the various DOM fractions (preferably of humic materials) were also observed for the metals in the same natural water sample. A high resolution ICP-MS system was applied to the element-specific interference-free detection of iron species in conjunction with an HPLC system. Iron could not normally be determined by a quadrupole ICP-MS because of spectral interferences. There are 39 references. Germany.

95-1187

**Determination of heavy metals in groundwater samples - ICP-MS analysis and evaluation**

M. LEITERER (Thuringia Agricultural Survey and Research Institute Jena) and U. MÜNCH

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 4/5, 204-209

Groundwater samples taken from suitable boreholes, wells and concrete or brick lined springs of the Thuringia observation network were subjected to water quality analysis. Inductively coupled

plasma mass spectrometry (ICP-MS) was used for the direct and simultaneous determination of aluminium, arsenic, cadmium, chromium, copper, manganese, nickel, lead and zinc. Spectral mass interferences attributable to great differences in groundwater matrices, precision and accuracy are discussed. Calibration was conducted externally using an aqueous multi-element standard, with 20 ppb of rhodium serving as an internal standard for all elements. A generally applicable matrix adjustment of the calibration standard was impossible. High carbonate or hydrogen carbonate levels (up to 9.6 mmol per litre in some places) and high calcium levels (up to 617 mg per litre) resulted in non-negligible interferences for chromium and nickel which required avoidance (or mathematical correction) by choosing appropriate isotopes. The accuracy of the analytical results was confirmed by comparative analyses of certified samples, recovery tests and by participation in collaborative tests. Germany.

95-1188

**Trace determination of Hg, Cu, Pb, Cd and Zn in specimens of the limnic environment using isotope dilution mass spectrometry with thermal ionization**

J. W. AIDMANN (Institute of Applied Physical Chemistry, Jülich), H. IMONS and H. W. DÜRRICH

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 4/5, 293-297

Data are presented for the determination of thallium, copper, lead, cadmium and zinc in homogenized extracts of bream, mussels (*Dreissena polymorpha*) and sediments from the Constance Lake/Constance estuary collected in the years 1981, 1985, 1988, 1990, 1992 and 1993. For comparison, bream were also collected from the Lake Linde district of Bornhöved, Bräur Lake in 1988, 1990 and 1992, and from the Sver river/Goudingen and Rehlungen in 1993. Isotope dilution mass spectrometry (IDMS) with thermal ionization was the method of choice. The analytical procedures which were developed for the trace metal analysis of biomonitors and sediment samples are described in detail. IDMS was suited for the reliable determination of thallium, lead and cadmium at low ng per kg levels. In comparison to other areas, thallium levels in mussels and bream from Constance Lake (Constance estuary) were remarkably large. These values, however, decreased during the monitoring period. It was necessary to identify the sources of thallium pollution by analysing further sediment and water samples, particularly close to industrial effluent discharge points. Germany.

95-1189

**Performance of a novel silica T-tube interface for the AAS detection of arsenic and selenium compounds in HPLC column eluate**

G. M. MOMPLAISIR (Macdonald Campus of McGill University, Ste Anne de Bellevue, P.Q.), J. LEE and W. D. MARSHALL

*Analytical Chemistry*, 1994, 66, No 20, 3533-3539

An improved interface was designed for the on-line atomic absorption spectrometric (AAS) detection of arsenic and selenium compounds in high performance liquid chromatography (HPLC) column eluate. Analytes contained within either an aqueous or a polar organic mobile phase were combusted in the hydrogen/oxygen atmosphere of a heated pyrolysis chamber contained within an expanded section of the lower portion of the fused silica T-tube device. Products were entrained into an unheated optical tube by the expanding gases. Low sub-ng chromatographic detection limits were obtained for arsenic, oxyanions, arsonium cations, selenium anions and selenium amino acids in aqueous or methanolic mobile phase. Arsenic anions and arsenic cations were co-extracted from aqueous solution, or from fish

## MONITORING AND ANALYSIS

muscle digests by phenol extraction and quantified in the same chromatographic run. Interface tubes were in continuous operation for up to 9 months without an appreciable loss of response (less than 50 per cent). The method was applied to the determination of arsenic species in a freeze-dried dogfish muscle standard reference sample (DORM-1). Results were comparable with those obtained by other chromatographic detectors. **Canada**

95-1190

### **Determination of chromium(III) and chromium(VI) in river water by electrothermal atomic absorption spectrometry after sorption preconcentration in a microwave field**

I. KUBRAKOVA (Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow), T. KUDINOVA, A. FORMANOVSKY, N. KUZMIN, G. TSYBIN and Y. ZHIGLOV

*Analyst*, 1994, 119, No 11, 2477-2480

The microwave sorption preconcentration of chromium under dynamic conditions is described followed by determination of chromium in the eluate or in the solid phase of the sorbent by ETAAS. Chromium species present in river water were separated by sorption on a polymeric Delata sorbent containing conformationally flexible aminocarboxylic groups. Microwave heating energy was used to promote the sorption. Quantitative sorption of chromium(III) was achieved at pH 7 and that of chromium(VI) at pH 3. Thus, complete isolation of the 2 species of chromium was possible. Optimal conditions of flow rate and sorbent volume were evaluated. The detection limit for both chromium species was 30 ng per litre and method reproducibility was good. **Russia**

95-1191

### **LED-compatible copper(II)-selective optrode membrane based on lipophilized zincon**

I. OFTIME (KE University, Graz), B. PROKES, I. MURKOVIC, I. WERNER, I. KLIMANT and O. S. WOLFFBEIS

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 7/9, 563-567

A copper(II) specific sensor membrane was developed for the measurement of copper(II) at pH 6 in drinking water and wastewater. The membrane consisted of a polyester support and an active layer composed of hydrogel, a hydroxylic plasticizer and Zincon (an indicator-dye complexing reagent). Zincon was fully compatible with light emitting diode (LED) sources in both its complexed and uncomplexed form, thus facilitating the use of plastic optical fibres and an internally referenced measurement scheme. A method is presented for immobilizing ionic dyes such as Zincon in hydrogel membranes involving the use of an ion pairing technique with tetraoxyl ammonium bromide. The membrane responded to copper(II) ions in giving a colour change from pink to blue. A kinetic approach was used for quantitation. A linear calibration graph was obtained for to 1-100  $\mu\text{mol per litre}$  (63.5  $\mu\text{g per kg}$  to 6.35  $\text{mg per kg}$ ) copper concentration range. An absorption maximum at 620 nm corresponding to the emission band of the orange LED was representative of the complexed form of the dye. No complexation of zinc occurred at the chosen pH of 6. The membrane was stable for periods in excess of 6 months when stored in dry and dark conditions.

**Austria**

95-1192

### **Determination of gold at the ultratrace level in natural waters**

R. CIDU (Cagliari University, Italy), L. FANFANI, P. SHAND, W. M. EDMUNDS, L. VANT DACK, and R. GUBELS

*Analytica Chimica Acta*, 1994, 296, No 3, 295-304

Several methods for the preconcentration of dissolved gold in natural waters were evaluated for use with graphite furnace atomic absorption spectrometry (GFAAS) or inductively coupled plasma mass spectrometry (ICP-MS). An anion exchange method (Bio-Rad AG 1-X8 resin, 100-200 mesh in the chloride form) prior to GFAAS, and a solvent extraction method (methyl isobutyl ketone, MIBK) prior to ICP-MS, both proved to have similar recoveries, low detection limits (0.4 and 0.2 ng per litre, respectively, for a 2 litre sample) and good reproducibility. Particulate gold was determined by instrumental neutron activation analysis (INAA) with detection limits between 0.04 and 0.5 mg per litre depending on the volume of filtered water. Thus, a complete evaluation of transported gold (dissolved and particulate) was made. The methods were applied to the determination of total gold in stream, spring and adit water samples from Wales, Scotland and Sardinia. The maximal dissolved gold concentration was 3 ng per litre, and particulate gold formed less than 50 per cent of the total amount of gold transported. No significant variation was found in the dissolved gold content of 1 spring water sample monitored monthly over a one year period. **Europe**

95-1193

### **Identification of diffuse and point sources of dissolved organic carbon (DOC) in a small stream (Alb, Southwest Germany), using gel filtration chromatography with high-sensitivity DOC-detection**

S. A. HUBER (Universitat Karlsruhe), A. BALZ and F. H. FRIMMEL

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 7/9, 496-503

To ascertain to what extent hydrophilic organic matter (OM) changes along the course of a stream, gel filtration chromatography and high sensitivity UV and DOC detection were used to study a small stream in South west Germany during the winter season. In the catchment area and upstream of 2 sewage plant effluents the organic load was low (below 1 mg TOC per litre) and dominated by humic substances (more than 80 per cent). However, downstream of the sewage plants, TOC increased up to 5 mg per litre while humic substances decreased to 30 per cent. Downstream analyses showed that the humic fraction was composed of fulvic acid precursors with associated non-humic material. Thus, the quality and quantity of organic constituents in the stream were dominated by the sewage inputs. This was relevant to the evaluation of these surface waters for processing for drinking water supplies. **Germany**

95-1194

### **Performance studies of an IR fiber optic sensor for chlorinated hydrocarbons in water**

R. GOBEL (Vienna Technical University), R. KRŠKA, S. NEAL, and R. KELLNER

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 7/9, 514-519

The performance of an infra-red (IR) fiberoptic device for chlorinated hydrocarbons (CHC) in water is discussed. The sensor consisted of a mid infrared region (MIR) transparent polymer coated silver halide fibre coupled to a commercial Fourier transform infrared (FTIR) spectrometer. This so called FEWS (fibre evanescent wave spectroscopy) device was tested with respect to temperature depend

ence, simultaneous CHC detection, sensitivity and dynamic response behaviour. The experimental results were modelled theoretically to better understand the diffusion process and to calculate the diffusion coefficient of the polymer to CHC. There was no real trend observed with changes in temperature from 0-22°C. The dynamic response to increasing concentrations of CHC was in the minute range whereas the regeneration of the system with distilled water took approximately 1-1.5 h. Purging the system with air reduced the regeneration time by a factor of 5-10. The specific absorption bands of CHC in the MIR enabled simultaneous detection of 3 different CHC compounds in water. The sensor was tested with 10 environmentally significant CHC and detection limits in the 1-50 mg per litre range were achieved. The sensing device was validated with headspace gas chromatography (HSGC) and showed good agreement with this established method. Thus, the FTIR fibre optic sensor appeared to be a promising tool for continuous monitoring of CHC in water. **Austria**

## 95-1195

**Toxicity assessment and on-line monitoring: immunoassays**  
B. HÖCK (Technical University of München at Weihenstephan, Freising), T. GIERSCH, A. DANKWARDT, K. KRÄMER and S. PÜLLEN

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 243-262

The use of immunoassays (IA) in rapid screening for pesticide residues is reviewed. The production of polyclonal (pAb) and monoclonal antibodies (mAb) and the advantages of using the highly specific mAb are explained. Competitive IA could be used for quantification of pesticides and their use for atrazines is described. Cross reactivity and matrix effects could cause error and validation by other methods was needed before a routine analysis was established. A practical guide specifies the method for the determination of atrazine with pAb and mAb and for the production of pAb for atrazine. There are 42 references. **Germany**

## 95-1196

**Validation of an automated precolumn exchange system (PROSPEKT) coupled to liquid chromatography with diode array detection. Application to the determination of pesticides in natural waters**

S. LACORTE (CID-CSIC, Barcelona) and D. BARCELÓ  
*Analytica Chimica Acta*, 1994, 296, No 3, 223-234

An automated, on-line solid phase extraction (SPE) method using C18 precolumns for the determination of various pesticides and their polar transformation products (TP) at 0.1 µg per litre levels in natural waters, was validated by participation in Aquacheck interlaboratory exercises, where more conventional gas chromatographic determinations were being used. The automated precolumn exchange system, known as PROSPEKT, was coupled to liquid chromatography with diode array detection (LC-DAD). Relevant parameters such as pH and type of precolumn (C18 and PLRP)s were optimized for several pesticides, herbicides and TP and calibration graphs were constructed at low levels of determination (0.1-1.5 µg per litre). For most of the studied compounds the overall relative standard deviation (RSD) between values obtained here and the average values obtained by 14-15 other laboratories varied between 1.6 and 36 per cent. Problematic organophosphorus pesticides were mevinphos (showed 2 peaks for cis- and trans isomers), parathion methyl and diazinon which coeluted, and malathion which was poorly quantified due to low UV absorption. Fenitrothion also gave 3-4 TP. These problems led to high variations in the mean values from different labora-

tories. It was possible to determine 11 pesticides in groundwater samples at levels varying from 0.02-0.2 µg per litre. It was thought that on-line SPE-LC-DAD-MS (thermospray mass spectrometry) would, in all probability, give the best results for organophosphorus pesticides albeit at higher cost. There are 30 references. **Spain**

## 95-1197

**Improving determination of polycyclic aromatic hydrocarbons in sediments: the need, and the solution of the problem**  
PAK-QIP.

J. L. FRERIKS (Institut voor Milieuraagstukken, Amsterdam), J. I. N. MAASKANT, J. W. WEGENER, A. H. BOEKHOFF and W. P. COITNO

*Hydro*, 1994, 27, No 24, 702-705 (in Dutch, English summary, p. 701)

Measures in The Netherlands to improve the determination of PAH in riverine, lacustrine and estuarine sediments are described. Previous inter laboratory studies had revealed wide variations in determinations on replicate samples, indicating the need for either or both of an improved and a standardized method. A cooperative programme between 38 laboratories, supported by the Ministry of Housing, Physical Planning and the Environment, the Institute of Inland Water Management and Wastewater Treatment, the Netherlands Standards Institute, the Agricultural University of Wageningen and the Free University of Amsterdam's Institute of Environmental Studies aimed to improve analytical quality performance through the development of 2 standard reference materials containing high and low levels of PAH and to recommend a standard analytical method. (English translation 195 pounds sterling, valid for 1995). **Netherlands**

## 95-1198

**Automated determination of pyrethroid insecticides in surface water by column liquid chromatography with diode array UV detection, using on-line micelle-mediated sample preparation**

F. R. BROUWER (Free University, Amsterdam), F. A. STRIJS, J. J. VREULS and L. A. J. BRINKMAN

*Presentia Journal of Analytical Chemistry*, 1994, 350, No 7/8, 487-495

To avoid sorption problems encountered during the storage and analysis of hydrophobic compounds such as pyrethroids, a method was developed which increased their solubility in water prior to detection. Thus, a liquid chromatographic (LC) method using gradient elution and diode array (DAD) UV detection was used for the trace level determination of a series of 7 pyrethroid test compounds following their automatic on-line preconcentration on precolumns of octadecyl bonded silica. The automated precolumn solid phase exchange system, known as PROSPEKT, was coupled to LC with DAD UV detection. Analyte breakthrough on the precolumn and adsorption to inner walls and surfaces was prevented by adding a neutral surfactant (Brij 35) to the aqueous sample. Detection limits were at the sub µg per litre level and repeatability was excellent. The procedure is described as robust and was applied to the analysis of surface waters. **Netherlands**

95-1199

**Identification and determination of polychlorinated phenols in the presence of chlororganic pesticides in water by high-performance liquid chromatography.**

M. A. KLISENKO (Institute of Labour Medicine of Ukraine, Kiev), Y. I. DAVIDYUK and V. F. DEMCHENKO  
*Journal of Water Chemistry and Technology* 1994, 16, No 1, 17-23

Normal phase high performance liquid chromatographic separation of 17 chlorophenols (CP) is reported. The influence of pKa, the number and arrangement of chlorine atoms and composition of the mobile phase on the separation of CP is discussed. Data are presented graphically and in tables. Optimal conditions for the separation of a mixture of CP in the presence of chlorinated pesticides and their transformation products were determined. A method for the analysis of water samples is presented. **Ukraine**

95-1200

**Determination of atrazine in water using tandem high-performance immunoaffinity chromatography and reversed-phase liquid chromatography**

D. H. THOMAS (Nebraska University, Lincoln), M. BLACK, WESTERMAYER and D. S. HAGG  
*Analytical Chemistry* 1994, 66, No 21, 3823-3829

An automated high performance immunoaffinity chromatography/reversed phase liquid chromatography (HPIAC/RPLC) system was developed for the determination of the herbicide atrazine in water samples. Atrazine and related compounds were extracted onto an immobilized antibody column, followed by separation and detection on the on-line RP-HPLC column. This technique used only 250 µl samples and required minimal sample pretreatment. No significant interferences from related triazines, other common pesticides or sample matrices were observed. Atrazine and its major degradation products were determined in 20 minutes with a throughput time of 10 minutes per injection. The atrazine calibration curve was linear over 2 orders of magnitude, and had a lower limit of detection of 0.1 µg per litre. Results obtained by this method were in good agreement with those obtained by gas chromatography/mass spectrometry (GC/MS) or gas chromatography/nitrogen phosphorus detection (GC/NPD) techniques. There are 36 references. **U.S.A.**

95-1201

**Adsorptive stripping voltammetry of lumichrome in sea water at the static mercury drop electrode**

G. SCARANO (Consiglio Nazionale delle Ricerche, Pisa) and F. MORILLI  
*Analytica Chimica Acta* 1994, 296, No 3, 277-284

The adsorptive stripping voltammetry (AdSV) of lumichrome (7,8-dimethylalloxazine), the principle product of riboflavin photolysis in seawater, is reported and the parameters affecting the stripping current were examined. Parameters such as preconcentration time and potential, pH of solution and mass transport conditions are discussed. Sensitive measurements were achieved after controlled adsorption followed by square wave voltammetry (SWV). The stripping peak current was proportional to the bulk concentration of lumichrome. The methodology was applied to raw seawater samples with a 600 seconds preconcentration time at minus 0.4 V. The value found was approximately 200 pM lumichrome. The method sensitivity was 0.05 nA per nM second, the reproducibility was 6 per cent at a concentration of 3.6 nM and the detection limit was 100 pM. The

results compared favourable with those obtained by solid-phase extraction followed by reversed-phase liquid chromatography. **Italy**

95-1202

**Investigation of the natural pesticide rotenone in water using liquid-solid disk extraction, supercritical fluid elution, and liquid chromatography/particle beam mass spectrometry.**

J. S. HO (U.S. EPA, Cincinnati, Ohio) and W. L. BUDDE  
*Analytical Chemistry* 1994, 66, No 21, 3716-3722

An analytical method was developed to monitor the naturally occurring fish toxin, rotenone, used widely in the U.S.A. as a pesticide on food crops, ornamental plants, in pet treatments and to reduce undesirable fish populations. The method development included sample storage studies, liquid solid extraction (C18 silica disks) elution from the disks with acetonitrile, modified supercritical carbon dioxide, and liquid chromatography/particle beam mass spectrometry (HPLC/MS). Measured rotenone levels in lock water samples were in good agreement with concentrations estimated from the dosing conditions used in a series of fish population and species diversity studies. Upon release of lock water into the lower Ohio river, rotenone levels were reduced to below the analytical detection limits (4 µg per litre). **U.S.A.**

95-1203

**A bioassay for determining simazine in water using aquatic flowering plants (*Ceratophyllum demersum*, *Ranunculus trichophyllus* and *Alisma plantago-aquatica*)**

Z. OI (Institute of Applied Ecology, Shenyang), T. SUN and H. ZHANG  
*Pesticide Science* 1994, 42, No 3, 173-178

A bioassay is described that uses *Ceratophyllum demersum*, *Ranunculus trichophyllus* and *Alisma plantago-aquatica* to measure simazine concentrations of 0.02 mg per litre in water within 10 minutes of treatment. The bioassay was based on the effect of simazine on the amount of oxygen produced by photosynthesis measured directly using a Clark type oxygen electrode. Mean recoveries of simazine from spiked river water measured by bioassays using *C. demersum* were 96 to 100 per cent compared to 98 to 100 per cent with C18 column extraction and HPLC measurement. The aquatic flowering plants were not susceptible to population fluctuations as were algae. **China**

95-1204

**Rapid field screening test for determination of 2,4,6-trinitrotoluene in water and soil with immunofiltration**

C. KEUCHEL (Munich Technical University) and R. NIESSNER  
*Fresenius Journal of Analytical Chemistry* 1994, 350, No 7/9, 538-543

An immunofiltration assay for the determination of 2,4,6-trinitrotoluene (TNT) in water and soil from sites around former ammunition production facilities was used as a rapid field screening test. The test was based on a simplified enzyme-linked immunosorbent assay (ELISA) performed in a pre-packed portable device. The test employed the wick-like properties of a cotton pad to suck the reagents through the membrane. The performance of the test was assayed in spiked water/methanolic soil extracts (dilution 1 to 10) and natural water samples. A quantitative colour response to concentrations of TNT in the range 1-30 µg per litre in water and 50-1000 µg per kg in soil was demonstrated. The relative standard deviations were 11.9 per cent and 14.1 per cent, respectively for water and soils. High correlations were observed between immunofiltration, ELISA

and gas chromatography results. The assay time of approximately 6 minutes per sample could be reduced to 4 minutes for on-site testing if antibody coating and blocking was set up in the laboratory. The variability of the immunofiltration assay was somewhat larger than for ELISA. This was thought to be due to the efficiency and uniformity of antibody coating and the variable flow rate of the reagents through the test device. Germany

## 95-1205

**A sequential gel filtration chromatographic method to estimate the molecular weight distribution of humic substances.**

S. TAO (Peking University, Beijing)

*Environmental Technology* 1994, 15, No 11, 1083-1088

A sequential gel filtration chromatographic system using Sephadex G 25 and G 100 gel columns in series coupled with UV detector that could measure almost the entire molecular weight distribution of humic substances was calibrated with 9 standard proteins (molecular weight 471-540 000 Da) for both molecular weight and resolution. A discrete fitting approach that accounted for the band spreading effect was used to relate the gel filtration chromatogram to the molecular weight distribution of the samples. Application of the proposed technique to samples from the Amur river yielded average molecular weights of 3600 and 5100 for dissolved stream and sediment humic substances, respectively, and the molecular weight distributions were separated into humic acid and fulvic acid fractions. Limitations of the technique are considered. China

## 95-1206

**Pyrolysis-GC-FTIR for structural elucidation of aquatic humic substances**

R. KUČEK (Institut für Spektrochemie und Angewandte Spektroskopie (ISAS), Dortmund), W. HILL, P. BURBA, and A. N. DAVIES

*Fresenius Journal of Analytical Chemistry* 1994, 350, No 7/9, 526-532

The application of coupled pyrolysis gas chromatography Fourier transform infrared spectroscopy (Py-GC-FTIR) to the structural elucidation of aquatic humic substances (HS) is described. The HS studied gave similar pyrolysis products, but in varying proportions. The pyrolysis products such as methanol, acetone, alkylbenzenes, cyclopentane, aliphatic acids, aromatic acids, acetamide, pyrrole, and phenols, were separated by GC and identified by their FTIR spectra using a digital library for automatic comparison (U.S. EPA and ISAS Infrared databases). Some of the compounds were related to lignin fragments which formed a large part of the humic substances investigated. Other products suggested the involvement of tetrapyrroles, fatty acids, furanoses, and amino compounds in the structure of humic macromolecules. Germany

## 95-1207

**Determination of thorium-234/uranium-238 disequilibrium in freshwater systems**

H. W. MORRIS (Manchester University), F. R. LIVENS, L. NOLAN, and J. HILTON

*Analyst* 1994, 119, No 11, 2403-2406

Techniques normally applied to thorium-234/uranium-238 disequilibrium measurements in marine systems have proved inappropriate in freshwater systems due to the much lower uranium concentrations in fresh waters. Thus, an alternative approach, based on a combination of Cerenkov and liquid scintillation counting and  $\alpha$  spectrometry, was used to improve the sensitivity of the technique for freshwater measurements. An outline of the radiochemical fractiona-

tion scheme is presented which allowed the processing of the large volume samples needed and permitted much longer count times for the thorium-234 fraction. Cerenkov counting of the high energy  $\beta$  emissions of both thorium-234 and the thorium-228 grand daughters was combined with liquid scintillation counting ( $\alpha$  and  $\beta$ ) and  $\alpha$  spectrometry. The method was very complex, requiring several separations and measurements and a non-straight forward calculation of results. U.K.

## 95-1208

**Determination of hydrogen peroxide in seawater by flow-injection analysis with chemiluminescence detection**

D. PRICE (Plymouth University), P. J. WORSFOLD, R. LAUZI, and C. MANTOURA

*Analytica Chimica Acta* 1994, 298, No 1, 121-128

A rapid flow-injection procedure with chemiluminescence detection is reported for the determination of hydrogen peroxide in seawater. The procedure was based on the hydrogen peroxide induced oxidation of an alkaline solution of luminol in the presence of a cobalt(II) catalyst. The reaction was optimal at pH 10-11. When the components were mixed, blue light ( $\lambda_{max}$  of 440 nm) was emitted with a maximal chemiluminescence intensity reached 2 seconds after mixing. A portable, automated version of the monitor was used on shipboard trials in the western Mediterranean. A typical depth profile for hydrogen peroxide is presented. The sample throughput was 120 per h with small sample volumes (100  $\mu$ l) and low detection limits (10 nM in Milli-Q water and 5 nM in seawater). U.K.

## 95-1209

**An advantageous reagent for the removal of elemental sulphur from environmental samples**

J. T. ANDERSSON (Westfälische Wilhelms Universität Münster) and U. HOEWITZ

*Fresenius Journal of Analytical Chemistry* 1994, 350, No 7/9, 474-480

The conditions for complete removal of elemental sulphur from environmental samples (such as sediments and sewage sludges) using polymer bound triphenylphosphine (TTP) as removal reagent were investigated. TTP was compared with several traditional de-sulfurizing agents including heavy metals, silver on silica gel, and tetrabutylammonium sulphite. For all reagents ultrasonication was much preferable to stirring or shaking the reaction solution. The advantages of TTP included quantitative reaction with sulphur, few side reactions with other sulphur containing analytes, ease of handling and non-hazardous products. TTP could also be regenerated and reused. It needed a fairly long reaction time (approximately 2 h) and extensive batch purification before use but these drawbacks were outweighed by the negligible side reactions. Germany

## 95-1210

**Utilization of sunglint for classification of lake surface area**

R. R. J. MOHLER (Lockheed Engineering & Sciences Company, Houston, Tex., U.S.A.)

*Geocarto International* 1994, 9, No 3, 59-62

The difference in 2 photographs of Chad lake taken during a space shuttle mission in 1988 illustrated the effect of sunglint on the images. Its saturating effects revealed water between the dune islands which could not be discerned in its absence. The photographs were digitized and classified by a maximal likelihood classification carried out by an image analyst. The areas of water classified with and without sunglint were 2843 and 1737 km<sup>2</sup>, respectively. The study



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would be extended to other lacustrine environments of different types. **Africa**

**95-1211**

**Potentials of photolytic rhodamine WT as a large-scale water tracer assessed in a long-term experiment in the Loosdrecht lakes.**

J. M. SUIJLEN (Ministry of Transport, Public Works and Water Management, The Hague), and J. J. BUYSE.

*Limnology and Oceanography*, 1994, **39**, No 6, 1411-1423.

A survey of rhodamine WT dye dispersed in the Loosdrecht lakes was carried out over a period of 19 months. The low concentrations of dye in lake water were determined by solid phase extraction and liquid chromatography with an on-line fluorometer detector. The detection limit was of the order of 20 ng per m<sup>3</sup>. The determination of the photolysis constant indicated comparable results from daylight and constant artificial light exposure, with an absence of photosensitizers in the lake water. Results from a numerical model developed to examine the dilution of a photolytic tracer indicated good agreement between observed and calculated results. Rhodamine WT was suited for long-term water tracing provided that photolytic effects were taken into account. There are 31 references. **Netherlands**

**95-1212**

**Solute dilution at the Borden and Cape Cod groundwater tracer tests.**

J. THIERKIN (Stanford University, Calif., U.S.A.) and P. K. KITANIDIS.

*Water Resources Research*, 1994, **30**, No 11, 2883-2890.

The rate of dilution of a conservative non-reactive tracer in 2 natural gradient groundwater tracer tests at Borden, Ont., Canada, and Cape Cod, Mass., U.S.A., was analysed. Two measures were used to quantify dilution: the dilution index and the reactor ratio. The dilution index was a measure of the formation volume occupied by the solute plume, while the reactor ratio was a shape factor which measured the stretching and deformation of the plume. Results for the 2 plumes were similar. After an initial period, the dilution index increased linearly with time, but the reactor ratio was relatively constant during the period of the experiments. The tracer used was sodium bromide. **North America**

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See also Abstracts 95-1148, 95-1150, 95-1160, 95-1247, 95-1468

**95-1213**

**DAF and ozone eliminate quality woes, meet new regs.**

**U.S.A.**

*Water Engineering & Management*, 1994, **141**, No 10, 27-29.

The upgrading and expansion work undertaken at the Millwood treatment works and pumping station in New Castle, N.Y., is described. The project involved the relining of old and deteriorated water mains, construction of a new pumping station and construction of a new water treatment facility. The treatment process incorporated live flocculation/dissolved air flotation (DAF) flow trains, with ozone used as the primary disinfectant. Centrifugal pumps generated the air-saturated water needed for the flotation process. Ozone was generated on-site and applied after clarification but before filtration. The works had operated successfully since completion in 1992. **U.S.A.**

**95-1214**

**State-of-the-art process control systems at waterworks.**

P. SCHERER (Gelsenwasser AG, Gelsenkirchen), and B. HORSGEN.

*Water Supply*, 1994, **12**, No 3/4, 263-275.

The introduction of modern process control technology into old waterworks is discussed. Compared with complete replacement of old, but often efficient, reliable pumping and electrical plant, the renewal of control equipment was often cost-effective even when non-standard solutions were required. Costs depended on works size, the nature of the process equipment and the status of the existing control system. Where previous monitoring was entirely manual, then the retrofitting of modern systems was particularly costly, going above the 10-20 per cent of total expenditure common at new waterworks. Two examples are given: in one case where 6 centrifugal pumps were coupled rigidly to turbines, the complicated arrangement was retained for 4 pumps; in the other example, the control room was retained while new equipment was installed without interrupting the process. **Germany**

**95-1215**

**Novel economic methods for disinfection and desalination of water.**

M. MOREL (Universite Cheikh Anta Diop (U.C.A.D.), Dakar, Fann), M. RUMEAL, A. ALI, M. PONTIE, A. DIBYE, and C. MAR DIOP.

*Tribune de l'Eau*, 1994, **47**, No 571, 31-38 (in French, English summary).

The technologies developed by the industrialized nations for disinfection and desalination of water and wastewater are usually much too expensive for use in developing countries and there is a need for simple, low-cost alternative solutions to the problem of treating and recycling of scarce supplies of water. Some possible methods capable of application in poorer countries are discussed, such as a combination of microfiltration and electrolysis, lagooning of treated effluents in the presence of aquatic plants (macrophytes), selective electro dialysis and reverse osmosis at high or low pressure. Where desalination of small amounts of sea water or brackish water is called for, the use of solar energy as a source of power offers economies over the use of fossil fuels. As a general rule, only those plants with a capacity of 10-12 m<sup>3</sup> per d could be economically powered by solar energy. A typical example of the use of lagooning to treat domestic wastewaters in a series of ponds supporting the growth of water lettuce (*Pistia stratiotes*) illustrated: the final effluent, after a retention time of approximately one week, was clear and could be used to irrigate banana plantations, while the plant tissue could be used as a mulch or for the production of compost. (English translation, 300 pounds sterling valid for 1995). **Senegal**

**95-1216**

**Rehabilitation for reduction of applied chemicals and removal of trace contaminants.**

H. BERNHARDT (Wahnbachtalsperrenverband, Siegburg).

*Water Supply*, 1994, **12**, No 3/4, 161-186.

Requirements for the production of safe drinking water are reviewed. Drinking water quality requirements are considered whose strictness appeared to dictate novel and advanced water treatment methods to reach the lower concentration of some organic and inorganic compounds specified, eliminate viruses and other parasites, minimize the use of chemicals, prevent harmful by-products and avoid the production of treatment sludge. Membrane filtration, adsorption on to alumina, recycling of flocculant by the use of magnetic microparti-

cies, ultrasound for deactivating and flocculating micro-organisms, and advanced oxidation processes involving UV, hydrogen peroxide and ozone are discussed. Although such processes were likely to be needed, it was essential that raw waters were protected by a comprehensive pollution control policy. There are 88 references. **Germany**

## 95-1217

**Aeration of non-flowing water bodies: an important initiative towards improving the environment.**

P. VLASE (Societe PEME)

*Eau, Industrie, Nuisances*, 1994, No 175, 34-37 (in French, English summary)

The processes involved in the transfer of oxygen across the air/water interface are discussed and the factors which govern the performance of aeration equipment in practice are also reviewed as a prelude to a description of a new type of surface aerator, the Sympar. This is driven by a submerged electric motor attached to a star-shaped float, with an impeller at the centre of the float which is level with the surface of the water. Due to the rotation of the impeller, water is drawn upwards into the eye of the impeller from which it is thrown further upwards into the atmosphere in a wide angle inverted cone. The action of physical forces atomizes the curtain of water: the droplets are aerated and then fall back onto the surface in a circle where they are mixed with the remaining water body. The unit can be installed in a tank or pond with a minimal depth of 0.5 to 1.5 m (depending on the size of the unit) and must be anchored in position with cables passed through special collars around the float. The methods of determining the performance of the unit are described: a specific oxygen yield of 1.8-2.0 kg oxygen per kWh can be achieved (English translation 105 pounds sterling, valid for 1995). **France**

## 95-1218

**Direct comparison of countercurrent and cascade crossflow air stripping under field conditions.**

S. VERMA (Louisiana State University, Baton Rouge), K. I. VALSARAJ, D. M. WITZEL, and D. P. HARRISON

*Water Research*, 1994, 28, No 11, 2253-2261

Groundwater contaminated by volatile chlorinated hydrocarbons was pumped at the same rate to cross flow (CFAS) and countercurrent air strippers (CCAS) receiving air from identical blowers. The columns of 0.3 m diameter and around 3.5 m high were packed with polypropylene rings, except that the CFAS column packing was confined by stainless steel screens so that the cross sectional area was not completely filled and air flowed across the packing directed by baffles. Column pressure drop and 1,2-dichloroethane stripping efficiency were measured as a function of air-to-water ratio using both equal water loading rates and equal water flow rates. Pressure drop in the CFAS unit was more than one order of magnitude lower than in the CCAS unit. This permitted air flows 4-5 times greater in the former than in the latter and consequently higher efficiencies. Long term tests showed that the CFAS column was less prone to fouling. **U.S.A.**

## 95-1219

**Magnetic microparticles in water treatment.**

L. O. KOLARIK (CSIRO, Clayton, Vic.), N. J. ANDERSON, B. A. BOLTO, C. T. CHIN, and A. J. PRIESTLEY

*Water Supply*, 1994, 12, No 3/4, 253-262

The Mark 2 version of the SIROFLOC process is described. In the commercialized Mk 1 process, coloured waters of medium to low turbidities were treated with magnetite at pH 5.5-6.0, separated

rapidly by a magnetic field, then regenerated with alkali and polyelectrolyte. The magnetite was recycled and the wash water was a waste product. The modified process, which was being examined in a pilot plant, treated more polluted water in conjunction with aluminium sulphate. The mixture of magnetite, impurities and precipitated alum salts was acidified and the magnetite separated. The re-dissolved aluminium salts with impurities were dosed with polyelectrolyte, settled and the alum recycled with additional coagulant. The latter was needed because some fulvic acid salts were being carried forward combined with the aluminium. Attempts to remove them had so far proved costly or complicated. This would be the subject of further research. **Australia**

## 95-1220

**Coagulation control and optimization: part one**

C. FIND (General Chemical Corporation, Syracuse, N.Y.)

*Public Works*, 1994, 125, No 31, 56-57

The use of coagulation in potable water treatment is overviewed. The coagulation process is described together with its control and optimization within overall facility optimization and improvement. Criteria influencing coagulant selection, demand and dosage are discussed. The most common coagulants were aluminium chemicals and iron salts, with synthetic organic polyelectrolytes and natural starch or gum-based materials often used as coagulation aids. Coagulation optimization programmes and non-mechanical facility controls such as fluoridation or treatment chemicals are described. The problems of hydrolysis and their solutions are discussed (see also following abstract). **U.S.A.**

## 95-1221

**Coagulation control and optimization: part two**

C. FIND (General Chemical Corporation, Syracuse, N.Y.)

*Public Works*, 1994, 125, No 12, 32-33

Good coagulant control in water treatment required low-cost methods which included routine laboratory tests and interpretation of operational data combined with sophisticated instrumentation. The properties and applications of the principal coagulants used in potable water treatment (aluminium sulphate, polyaluminium hydroxychloride, ferric chloride and ferric sulphate) are discussed. The control and optimization of coagulation is described. This included zeta potential measurement devices, streaming current detectors, pilot filters and coagulant residual monitors (see also preceding abstract). **U.S.A.**

## 95-1222

**Slow sand filters covered by geotextiles**

H. P. KLEIN (Zurich Water Supply) and C. BERGER

*Water Supply*, 1994, 12, No 3/4, 221-230

Open slow sand filters used in Zurich as infiltration basins for the artificial recharge of groundwater were covered by a commercial polyethylene or polypropylene non-woven synthetic fabric with 10 cm of granular activated carbon or stone chips beneath it. Its purpose was to inhibit algal and plant growth in the sand, form a barrier against coarse impurities and prevent fine sand being blown away. Among the required properties were a pore size of around 0.1 mm, resistance to degradation by UV light, transmission below 20 per cent, layer thickness of 1-3 mm, high resistance to damage, and low price. The membrane required renewal every 3-4 years with skimming and washing of the top 10 cm of sand every 10-12 years. This compared with skimming the top 5 cm every 1-5-20 years and re-sanding after 10-15 years in the absence of geotextile. Pre-oxida-

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tion with 0.3 mg each of chlorine and chlorine dioxide per litre prevented excessive algal growth. **Switzerland**

95-1223

**Release of arsenic from model wastewater treatment solids: a mechanism based on surface ligand exchange.**

C. R. PAIGE (McMaster University, Hamilton, Ont.), W. J. SNODGRASS, R. V. NICHOLSON and J. M. SHARER  
*Water Pollution Research Journal of Canada* 1994, 29, No 4 507-530

The mechanisms controlling the release of arsenic from model water treatment solids under oxic conditions were investigated. Model solids were synthesized in the form of non-crystalline ferrihydroxide/arsenic coprecipitates. The loss of arsenic was determined using neutron activation analysis. Arsenic was slowly released from coprecipitates with ferrihydrite for several hundred hours, accompanied by crystallite growth. As the level of arsenic in the system increased from 0 to 1 per cent, ferrihydrite transformed successively into goethite, goethite plus  $\alpha$ -haematite,  $\alpha$ -haematite alone, and finally remained amorphous. The crystalline solids did not contain arsenic in the form of solid solutions. The specific surface area was a function of the arsenic content of the coprecipitate. With increasing arsenic content the specific surface increased up to a maximum. The rate of loss of arsenic from coprecipitates was described by a surface exchange model for unstirred solids under oxic conditions. The activation energy for the surface exchange reaction was 40 kJ per mol. There are 53 references. **Canada**

95-1224

**The grow faster bug.**

I. EDWARDS

*Water Bulletin* 1994, 634, 8-9

Anglian Water and Purac Rosewater have developed a biological iron removal system for water that it was expected to compete with both conventional and other biological iron removal processes. The East Ruston water treatment works was experiencing difficulties in meeting EC maximal admissible iron concentrations in drinking water, and had installed a pilot plant in which the water was pumped directly from the boreholes into the reactor where it passed through the media bed and the micro-organisms. Air was injected into the reactor column to control the oxygen level, and the water then passed through a balance tank to the aeration tower where the normal treatment system continued. An advantage of the system is that the manganese content is also reduced. Within 3 days of the plant being commissioned, the iron concentrations were cut by a 12-fold factor so that they approached the EC guideline limit of 0.05 mg per litre. **U.K.**

95-1225

**Activated carbon based biological fluidized beds for contaminated water and wastewater treatment: a state-of-the-art review**

R. M. SUTTON (P.M. Sutton & Associates, Bethel, Conn.) and P. N. MISHRA

*Water Science & Technology* 1994, 29, No 10/11 309-317

The state of the art of biological fluidized beds based on granular activated carbon used to treat contaminated aqueous streams is reviewed. The historical development of the technology, process and component design and commercial applications are considered. The basis of the technology is the ability of fluidized bed systems to intensify biological reaction rates through the accumulation of high concentrations of active biomass. Present interest in the use of

granular activated carbon as the fluidizing medium is discussed, and details of commercial applications of this system, many treating petroleum hydrocarbons or chemical wastewaters, are given. There are 40 references. **U.S.A.**

95-1226

**Advances in biofilm aerobic reactors ensuring effective biofilm activity control.**

V. I. AZAROVA (E. Yonnaise des Eaux-Dumex, Le Pecq), and J. MANEM

*Water Science & Technology* 1994, 29, No 10/11 319-327

The development of advanced biological treatment systems designed to overcome the limitations of conventional systems is reviewed with particular attention to new types of biofilm reactors with granular media. Performance, reactor configurations, scale-up considerations, energy consumption and field of application are examined. Advantages and disadvantages of advanced aerobic biofilm processes are considered with particular attention to factors and techniques designed to ensure effective control of biofilm thickness and mass transfer. Three phase bioreactors offer the best prospect of effective biofilm control. There are 55 references. **France**

95-1227

**Results and experience with the NEBIO tube reactor process in the water treatment plant Coswig near Dresden.**

E. BOEHLE (DVGW Forschungsstelle Karlsruhe, Dresden), I. HAIJENWANG and G. SCHWAB

*Water Science & Technology* 1994, 29, No 10/11 497-508

An application of the NEBIO downward flow fluidized bed tube reactor to water treatment at the Coswig works near Dresden is reviewed. A pilot scale unit with a capacity of 650 m<sup>3</sup> per d began operation in 1989. Successful denitrification performance led to the commissioning of 2 demonstration units with a water throughput of 61 000 m<sup>3</sup> per d in 1992. Post treatment consisted of aeration, multi-layer and activated carbon filtration, pH adjustment and two stage disinfection with chlorine. Following confirmation of biological nitrate elimination, water was first fed into the public supply system in November 1992. Work was continuing to optimize the technology. **Germany**

95-1228

**Fluidized bed reactor operation for groundwater denitrification**

M. GREEN (Technion-Israel Institute for Technology, Haifa), M. SHNITZER, S. TARRE, B. BOGDAN, G. SHELEFF and C. J. SORDEN

*Water Science & Technology* 1994, 29, No 10/11 509-515

A laboratory scale fluidized bed reactor using sand particles as the biomass carrier was used to remove nitrate from groundwater. Denitrification was achieved at very high nitrate loading rates (between 30 and 100 kg nitrate per m<sup>3</sup> d) and with correspondingly short retention times (1.5 to 5 minutes). The effects of the nitrate loading rate on nitrate and nitrite removal, reactor biomass profiles and biofilm characteristics were studied. The results suggested that this type of reactor could achieve successful denitrification at retention times lower than 3 minutes and nitrate loading rates higher than 70 kg nitrate per m<sup>3</sup> d, though careful control of biofilm thickness was necessary. **Israel**

95-1229

**Numerical modelling of a biofilm-electrode reactor used for enhanced denitrification.**

J. R. V. FLORA (Cincinnati University, Ohio), M. T. SUIDAN, S. ISLAM, P. BISWAS, and Y. SAKAKIBARA

*Water Science & Technology*, 1994, 29, No 10/11, 517-524

A biofilm-electrode reactor was used to enhance biological denitrification. Nitrate removal efficiencies greater than 98 per cent were achieved. Earlier researchers had shown that nitrate removal could be improved by subjecting immobilized enzymes and biofilms to an electric current. A laboratory-scale reactor was constructed to evaluate the enhancement and control of denitrification in a continuous flow system. A biofilm model taking account of the effects of hydrogen inhibition kinetics, gas production within the biofilm and the presence of a phosphate buffer was developed. The model was coupled to a model of a completely stirred tank reactor. Close agreement with experimental results was achieved at currents in the range 0-20 mA. U.S.A.

95-1230

**New possibilities of adsorption filtration in water conditioning technology and wastewater deep purification.**

V. V. GONCHARUK (A. V. Dumanski Institute of Colloid

Chemistry and the Chemistry of Water, Kiev), N. A.

KLIMENKO, A. M. KOGANOVSKII, and M. N.

TIMOSHENKO

*Journal of Water Chemistry and Technology*, 1994, 16, No 2, 12-20

The potential for treating potable water supplies in the Ukraine by carbon adsorption is discussed. Costs of regeneration, sorption capacity and bed life, and regeneration technology are discussed. Sorption properties of a new carbon, Akant Meso, are compared with those of other carbons. Application of carbon adsorption to the reduction of permanganate oxidizability of Desna river water and of the COD of biologically treated wastewaters and effluents are reported. Ukraine

95-1231

**The prediction and optimization of pesticide removal by GAC-filtration.**

R. HOPMAN (Kiwa n.v. Research and Consultancy

Nieuwegein), M. A. MLIRKERK, W. G. SIEGLERS, and J. C.

KRUTHOF

*Water Supply*, 1994, 12, No 3/4, 197-207

The performance of a granular activated carbon (GAC) column for pesticide removal was predicted by laboratory isotherm and mini-column tests. Adsorption isotherm tests with pure solutions yielded comparative data which over-predicted GAC lifetimes. Actual capacities were much lower because of adsorption kinetics and competition from natural organic matter (NOM). In 2 week mini-column tests, column diameters and GAC particles were scaled down according to accepted formulae to predict the performance of actual adsorbers. This method could also compare different adsorbents, pesticides, pre-treatment and the effectiveness of reactivation. NOM removal before GAC filtration, by washing GAC with sodium hydroxide solution, and multi stage adsorption improved pesticide removal. Netherlands

95-1232

**For peat's sake**

L. STEDMAN

*Water & Environment Management*, 1994, No 21, 36-37

The upgrading of Grampian Regional Council's Invercarnie water treatment works, serving Aberdeen, to the standards for colour required by the EC Drinking Water Directive and by popular demand from an immigrant population unaccustomed to the colour of peaty water is described. Raw water comes from the Dee river, rich in organics from the peaty moors and forest leaf litter. Alternative processes to remove the organics, one based on coagulation with magnetite, the other on ozonation, were evaluated on site. Ozonation was preferred, and will be introduced via air generated ozone injected into over and under baffled contact tanks between the raw water storage reservoirs and the existing battery of 17 slow sand filters. Disinfection will continue to be by chlorine, a lower dose than hitherto probably being required as the ozone will have destroyed most of the organics, and pH correction will continue to be by lime. The precautions taken to prevent damage to equipment and to the health of the staff by excess ozone are detailed. U.K.

95-1233

**Combination of ozone and flotation to remove algae**

V. BOISDON (Compagnie Generale de Eaux, Maisons Laffitte,

France), M. M. BOURBIOU, E. NOGUEIRA, D. WILSON, and

J. LEWIS

*Water Supply*, 1994, 12, No 3/4, 209-220

The removal of algae from raw waters was investigated in 2 pilot plants. Water initially flowed counter current to ozone bubbles of varying size and then carried the finer bubbles forward into a flotation chamber where algal flocs rose to the surface aided by a flocculating agent. Filtration in an anthracite/sand filter completed the removal of algae. The pilot plants and 3 full scale plants achieved 60-90 per cent removal of algae by ozoflotation. Performance depended on the type of algae, their number, and raw water quality. The treatment decolorized the water, reduced taste and odour, decreased clogging and so gave longer filter runs. Europe

95-1234

**Inactivation of microorganisms by ultrasound**

J. CLASEN (Wahnbachtalsperrenverband, Siegburg) and R.

SOROTTA

*Water Supply*, 1994, 12, No 3/4, 243-251

The inactivation of microorganisms by ultrasound was studied in laboratory and pilot reactors. The former examined the survival of *Artemia salina* and *Cyclops nauplius* in a cubic sound tank of side 40 cm. Inactivation rates of 99 per cent were achieved within 30 seconds at an energetically optimal sound intensity of 0.8 W per cm<sup>2</sup> over a frequency range of 20-40 kHz. Higher frequencies required greater intensities. The inactivation, which required no chemicals but was improved by increasing gas content, was caused by mechanical forces in the ultrasonic cavitation. The pilot reactor gave 95 per cent inactivation at a flow of 8000 litres per h at a specific output of 1.2 W per litre. An industrial design would probably have piezoelectric transducers yielding 300 kW; its optimal geometry had not been determined. Likely treatment costs were 0.026 DM per m<sup>3</sup>. Germany

## WATER TREATMENT

95-1235

### Oxidation processes: reaction-rate modelling.

J. HOIGNE (EAWAG, Dübendorf)

*Water Supply* 1994, 12, No 3/4, 187-195

The prediction of non-microbiological chemical oxidation processes by kinetic data and modelling is explained and illustrated by a detailed consideration of the rate of bromate formation during ozonation of waters containing the bromide ion. General conclusions from this exercise indicated that oxidative transformation rates could be predicted from appropriate reaction rate constants and treatment plant characteristics. Separation and formulation of the principal chemical reactions, reaction rate data, kinetic formulations for the reactions of collective parameters, reaction rate constants for ozone and hydroxyl radicals were required together with parameters for the reactor and concentration time values. The quality of the water had to be characterized and sub-models tested in the laboratory. The method could also be applied in principle to oxidation by chlorine dioxide and chlorine. **Switzerland**

95-1236

### Softening process comparisons: degree of softening and types of ions removed

H. M. SCHNEIDER (Schneider Enterprises, Burlington, Wis.)

*Ultrapure Water* 1994, 11, No 8, 22-31

A review of the chemistry of water softening is given. Data are given on the performance expectations of cold and hot lime-ion exchange and nanofiltration under a wide range of operating conditions, including temperature, pH, and total dissolved solids concentrations, where the salt rejection capacity of the membrane process becomes most sensitive. Practical considerations are dealt with and include the production of softening sludge, the need for regeneration of resins, the high temperature operating limitations of membranes and the proportion of feed water that can be recovered as product water. The requirement for pumping to pressurize a membrane system, the need for pretreatment to ion exchange and membrane systems, sensitivity to chlorine, the layout of the components of a softener, the disposal of wastewaters, the suitability of the product water as a potable water, the ability of the processes to reduce organics and colour, and costs are also considered. **U.S.A.**

95-1237

### Uniform resin particle size technology in the water demineralization process

J. R. WILSON (Rohm and Hass Co., Philadelphia, Pa.) and J. J. McNUITY

*Ultrapure Water* 1994, 11, No 8, 62-68

The ability of a manufacturing process (jetting) to produce ion exchange resin beads of a consistent size led to investigations into the performance of beds of them as compared with beds where the range of bead sizes was greater. No change to ion exchange chemistry would be involved, but it was considered that operational advantages might be found. Although the exchange capacity of strongly basic anionic resins showed little variations between the 2 forms, strongly acidic cation resins in the monodisperse form showed an increase in capacity, the increase being greater as total dissolved solids concentrations rose by 4 per cent at 300 ppm, 15 per cent at 500 ppm (and rising). Rinse requirements were lower, but only at the 2 uS per cm end point level. Pressure drop across the monodisperse bed was smaller, as a result of the slightly larger void volumes, while such a bed also fluidized more readily on backwash, thereby reducing the volume of backwash water required. Less fragmentation of the beads was also noted. **U.S.A.**

95-1238

### Pretreatment requirements for reverse osmosis systems.

W. F. HARFST (Harfst and Associates, Crystal Lake, Ill.)

*Ultrapure Water* 1994, 11, No 8, 42-44

The need for an understanding of the necessity for pre-treatment of a water before its admission to a membrane-based system, such as reverse osmosis, is outlined. The several factors that could cause clogging, including carbonate scale, colloidal clay and silica, carbon particles, dead and living bacteria, and the products of chemical oxidants added to control them, are detailed. An analysis of the water to be treated to determine the presence and concentration of these is essential; this should be supplemented by further tests, such as the Silt Density Index test or the Cross-flow index test to indicate the water's clogging potential. The means by which foulants can be removed are considered: softening, various types of filtration (cartridge, multi-media, depth, activated carbon), acidification, anti-scalant addition, chemical cleaning, chlorination and de-chlorination are discussed in the context of their functions and what disadvantages they might bring. **U.S.A.**

95-1239

### Rehabilitation of water treatment plant: impact of membrane filtration.

Y. RICHARD (Degremont, Le Pecq)

*Water Supply* 1994, 12, No 3/4, 231-242

The value of ultrafiltration (UF) and nanofiltration (NF) in water treatment are discussed with examples. Generally, a pre-treatment filter was essential. Membrane filtration was usually crossflow with considerable recirculation of filtered water. Membranes were regularly backwashed until poor performance dictated a more elaborate detergent wash. UF was sufficient for the removal of all micro-organisms. In combination with powdered activated carbon it could also deal with algae, taste and pesticides. Polluted raw waters required conventional treatment concluding with sand filtration before UF. Nanofiltration could replace ozonation and granular activated carbon as the final polishing step in water treatment. A demonstration plant had removed micro-organisms, biodegradable DOC, disinfection by-products, reduced micropollutants and effected a degree of softening. Although investment and operating costs were higher than conventional processes, these were promising alternative methods. **France**

95-1240

### Surface water reverse osmosis system biofouling

W. G. WEBB (Lower Colorado River Authority, La Grange, Tex.) and D. PAUL

*Ultrapure Water* 1994, 11, No 8, 38-40

Difficulties caused by biofouling of a thin film reverse osmosis membrane system are outlined. The reverse osmosis stage had been retrofitted to the water treatment sequence of a power station to prolong the times between regenerations of the demineralizer ion exchange beds, and to cut down on the chemical costs involved. However, high summer temperatures of the raw water (up to 95°F) proved ideal breeding grounds for bacteria in the piping system. Since the thin-film membranes were sensitive to chlorine, any chlorine added to the piping to control the bacteria had to be removed before the membrane. Chlorination had the effect of causing sufficient kill of bacteria to cause them to slough away from the pipe walls, thereby clogging the membrane, but not sufficient to remove the entire mass. Dis-assembly of the pipework revealed a biological growth 0.25 in thick on the pipe walls, which had to be removed by high pressure flushing and sanitization. Such cleaning should be a

routine procedure, as should bacterial monitoring to indicate when to undertake it, and de-chlorination should be practised as closely as possible to the input to the membrane. U.S.A.

95-1241

## IPP and COGEN electrical generators provide important water treatment market.

M. HENLEY

*Ultrapure Water*, 1994, 11, No 8, 16-21

A summary of the market for high-purity water treatment of various types of the U.S. electricity generating capacity not owned by municipalities is given. Estimates of the installed capacity of independent power stations varied by almost 100 per cent, but even taking the upper end of the range the percentage of total national installed capacity was under 5. Some generators supplied electrical power only; others, known as cogenerators, were obliged to return some of the hot water or steam used for production to the facility from where they obtained it. The various types of fuel used by independent producers, their water sources, and the types of treatment selected are outlined. U.S.A.

95-1242

## Retrofitting RO in front of ion exchange - part 2: technical and economic factors.

A. WHITLEY (Mississippi Power Co., Gulf Port, Miss.), D. DRUMMONDS, and B. HAMILTON

*Ultrapure Water*, 1994, 11, No 8, 32 and 34-35

Data from a pilot scale study to assess the technical and economic viability of using reverse osmosis, with appropriate pre-treatment as a pre-treatment stage to the demineralizer chain in the water treatment of a power station are presented. The existing arrangements required very frequent regeneration of the ion exchange resins, with associated high chemical costs. 2 sets of beds were provided, to allow for down time. A portable reverse osmosis unit was tried, for an operational period of 3 months, in front of them, and proved highly satisfactory. Regeneration frequency was reduced by at least 90 per cent, and demineralizer water conductivity lowered from 60 umhos/cm to less than 10 umhos/cm. These improvements gave an economic advantage in operation that would outweigh the capital cost of the equipment. (See also Aqualine Abstract No 95-0793). U.S.A.

95-1243

## A new system for high-purity water production.

S. OJIMA (Nomura Micro Science Co. Ltd., Atsugi City), M. ABE, and Y. YAMAKI

*Ultrapure Water*, 1994, 11, No 8, 45-48 and 50

A description is given of a water and wastewater treatment system developed for a semiconductor works in Japan, in which some of the component processes were shared. The recovery and re-use of between 30-80 per cent of the wastewater as process water had advantages in reducing expenditure on high-priced municipal water, minimizing the effects of water shortages, limiting the volume of water discharged to sewer, improving the company's environmental image, and retaining space where land was at a premium and land values high. In the case outlined, the water to be recovered was of a quality at least as good as the municipal supply. The proportion of wastewater to throughput water generated at various process points is indicated, and the function of various components of the system are outlined. In the integrated system developed, the activated carbon column, the ion exchangers, and the reverse osmosis stage were shared by the 2 streams. The UV stage comprised 2 lamps in series, operating at half the irradiation intensity of the previously used

high intensity lamp, with attendant cost savings. The new system had permitted the abandonment of 3 components previously dedicated to the wastewater recovery stream, an activated carbon unit, a hydrogen peroxide injector and a reverse osmosis unit. The quality of process water was satisfactory. Japan

95-1244

## Operating experiences with Type 2 resins in makeup demineralizers.

M. C. GOTTLIEB (Resin Tech Inc., Cherry Hill, N.J.), K. HLEGLE, and J. CHAMBERS

*Ultrapure Water*, 1994, 11, No 8, 51-56 and 58-61

The enhanced performance of make-up water demineralizers used at 3 U.S. boiler using installations (2 power stations and a factory) when they replaced the types of resin they had previously used in their ion exchangers with Type 2 resin is demonstrated in case studies. Type 2 resins offered advantages, particularly their ability to withstand higher temperatures, and their lower silica leakage. In practice, they retained their initial exchange capacity longer, and required a less demanding rinsing procedure. Operational benefits have been demonstrated over the long term (at least 2 years).

U.S.A.

# UNDERGROUND SERVICES AND WATER USE

See also Abstracts 95-1003, 95-1019, 95-1022, 95-1025, 95-1032, 95-1064, 95-1078, 95-1079, 95-1134, 95-1149, 95-1213, 95-1302, 95-1307, 95-1308, 95-1313, 95-1429

95-1245

## A robust integrated computer-aided design package for urban drainage networks

K. W. CHAI (Hong Kong Polytechnic, Kowloon) and S. L. NG

*Water Science & Technology*, 1994, 30, No 1, 117-120

The development and verification of DRAINAGE, a computer-aided design and drafting package for medium-sized municipal stormwater drainage systems, is described. The program was written in TURBO PASCAL version 6.0 for use on personal computers. It used the Colebrook-White equation to describe the range of pipe flow and to calculate the water velocity and pipe capacity. The Rational Method is used to estimate design peak runoff to be conveyed in the pipes. The program routed pipe flows through tree-type drainage networks and automatically adjusted drainage pipe diameters to fulfil flow requirements and backwater effects. The program outputs are written as DXF files which can be read and displayed readily as drawings of drainage layout plan and longitudinal profiles in an AutoCAD environment. The program was developed for the design of a stormwater drainage network in Hong Kong but it could be adapted for other situations. Hong Kong

95-1246

## Turbulent flow in pipes: a historic speculation

G. D. MATTHEW (Aberdeen University)

*Water, Maritime and Energy*, 1994, 106, No 4, 311-316

The historical derivation of the laws of turbulent flow in pipes is discussed. Ways in which these derivations might have changed had Darcy's empirical evidence and equation (1855) been incorporated from the start in a 2 parameter alternative to Prandtl's original

## UNDERGROUND SERVICES

mixing length assumption are examined. Equations were derived which showed that by selecting a rational fraction form for the mixing length integration in closed form to give the velocity profile over the bulk of the cross section was still possible. The subsequent integration to give a friction factor relationship was also possible. Incorporation of the Colebrook White relationship for roughness of the pipe wall is also discussed. U.K.

95-1247

### **Survey of stainless steel performance in low chloride waters.**

A. H. TUTHILL (Tuthill Associates Inc. Blacksburg, Va.) and R. F. AVERY

*Public Works* 1994, 125, No 12, 49-52

Findings of a user survey of stainless steel performance are reported. Stainless steel composition is outlined. Its use in municipal potable water distribution systems, potable water treatment facilities, building water supply systems, wastewater treatment works, household plumbing systems, dams, locks and hydroelectric facilities was examined. Corrosion and leakage problems found are discussed. U.K.

95-1248

### **Preparation and injection of reagents - 'from the pump to the process'**

L. F. GILLET (PCM Pompes)

*L'au Industrielle Nourances* 1994, No 175, 43-44 (in French, English summary)

The importance of absolute reliability, in addition to correct performance in terms of concentration and flowrate, when dosing chemicals in very critical installations, such as high pressure boilers for power stations, is discussed. For such applications the consequences of pump failure, where only a single pump is used, could be disastrous, and to guard against such events, a multiple dosing system is usually employed. As an example of the application of this method, a special array of pumping and solution preparation equipment was supplied for use at the Jorf Lasfar power station in Morocco, under contract to GEC-Alsthom. The pumps necessary for pH adjustment, deoxygenation and phosphate dosing to the boiler feedwater were installed on special skid mounted frameworks on which all the necessary pipework, feed tank, and dosing equipment are situated, including stand-by pumping equipment. These units are supplied ready for immediate use. The nature of the equipment provided for ammonia injection and hydrazine dilution and injection on one of these skid mounted units is described. (English translation 45 pounds sterling valid for 1995). Morocco

95-1249

### **Historical perspective and corporate overview**

L. H. BENSTED (Thames Water Utilities Ltd)

*Proceedings of Institution of Civil Engineers* 1994, 102, Special Issue 2, 1-8

The background to the development of the 248 million pounds sterling Thames Water Ring Main (TWRM) formerly the London Water Ring Main is described. The TWRM had been constructed over the last 8 years and consisted of 80 km of mostly 2.54 m diameter concrete lined tunnels, linking London water treatment centres across the city. The robust link distribution system could now meet a wide range of supply contingencies. Design and operational planning of the TWRM is described and the route plan outlined. The corporate benefits of the TWRM are discussed including trunk main integrity and operating efficiency, treatment rationalization, security

of supply and water quality, leakage control, low river flow alleviation and environment and water resources. U.K.

95-1250

### **Pipe down.**

N. DAVIS

*Survivor* 1994, 181, No 5316, 15-18

Progress to date on the 33 million pounds sterling project by Anglian Water to improve water quality and supply in the Humber Bank area is described. The scheme included 2 new storage reservoirs, some 50 km of new water main and modernization of several pumping stations. Environmental, strategic and construction aspects of the two 5.6 million pounds sterling mains laying contracts being undertaken by Birse Construction are discussed. U.K.

95-1251

### **Water distribution system performance indicators**

A. K. DEB (Roy F. Weston Inc. West Chester, Pa.)

*Water Supply* 1994, 12, No 3/4, 11-20

An overall view of distribution system performance indicators and methods of assessing the performance of distribution systems is presented. Performance indicators and measures are grouped into structural, hydraulic and water quality categories. Structural and hydraulic measures consider adequacy, dependability, efficiency and quality of service. These are the important performance measures but they can not be measured directly. Water quality measures address bacteriology, aesthetic and other aspects of quality. Primary and secondary performance measures are proposed. A 6 step methodology is suggested to monitor and improve distribution systems. The steps involve reviewing historic data on system performance, setting up performance goals, data collection, diagnosis of problems, developing corrective action, implementing remedial measures and evaluating performance goals. U.S.A.

95-1252

### **Civil engineering and tunnel design**

J. P. FARROW (Thames Water Utilities Ltd) and P. M. CLAYE

*Proceedings of Institution of Civil Engineers* 1994, 102, Special Issue 2, 23-33

The design of the shafts, tunnels and pumping stations and associated civil engineering works for the Thames Water Ring Main (TWRM) is described. The TWRM consisted of 80 km of tunnels with 11 major underground pumping stations. Details are given of the design and testing of the shafts, the wedgeblock and non wedgeblock tunnel systems, the segmental lining and the underground structures. The project was completed and commissioned in 1994, two years ahead of programme and within the 250 million pounds sterling budget. U.K.

95-1253

### **Planning and design of the Holland Park shaft**

C. J. A. BINNIE (W.S. Atkins), P. M. WHITE, B. PEARCY and D. WEIL

*Proceedings of Institution of Civil Engineers* 1994, 102, Special Issue 2, 34-42

The integration of engineering, environmental and planning aspects in the design and planning of the Holland Park pump-out shaft for the Thames Water Ring Main is described. Fifteen alternative shaft sites were ranked using a multi factor environmental evaluation and on cost and economic criteria. A detailed feasibility study had also shown that the selected site could be used as both as a pump-out shaft and a tunnel construction shaft. The adopted design solution was

cost-effective with low environmental impact. Construction proceeded on schedule following granting of planning permission by the local authority. U.K.

95-1254

**Technical and logistic achievements on the large scale of the South Holland pipeline project.**

S. de JONG (Visser & Smit Hanab)

*Hydro* 1994, 27, No 23, 686-688 (in Dutch, English summary p.669)

The construction of a 54 km-long pipeline of diameter up to 1.6 m between Bergambacht and Wassenaar in the west of The Netherlands is described. The 3-year project begun in 1992 includes auxiliary works, and is designed to ensure security of supply to more than 1 million consumers in the areas of the South Holland Dune Water Company. A broad range of techniques including tunnelling and floating sections of pipeline into position with on site coating arrangements is being adopted. For particularly difficult sections of the project such as where crossing of existing underground services is involved the Company engaged the services of the Netherlands firm Visser and Smith. (English translation 135 pounds sterling incl. for 1995). **Netherlands**

95-1255

**Route planning, statutory procedures and survey control**

P. L. STANFORTH (Thames Water Utilities Ltd), J. D. LEWIS

D. L. B. JONES and W. M. HEDDEN

*Proceedings of Institution of Civil Engineers* 1994, 102, Special Issue 2, 14-22

Some of the planning and design considerations that governed the selection of tunnel alignments and sites for the associated shafts on the Thames Water Ring Main are examined. Buried obstructions, surface development, geology and hydraulic requirements were key constraints affecting tunnel alignment. The location of shafts was generally dictated by the need to make hydraulic connections to specific points within the surface pipework recirculation system. Risk identification is outlined. Geotechnical aspects are discussed in relation to local geology. The survey techniques used for control at the surface and transfer to the tunnel face are described. Experiences gained from this project are discussed. U.K.

95-1256

**Tunnel construction**

M. DICK (Thames Water Utilities Ltd) and P. A. JAKUES

*Proceedings of Institution of Civil Engineers* 1994, 102, Special Issue 2, 43-54

The Thames Water Ring Main (TWRM) involved the construction of 80 km of tunnels needed for the transfer of raw and treated water. Tunnel construction was carried out during August 1987 to February 1993 using open face shields and tunnel boring machines (TBM). Geology of the TWRM tunnel drives is outlined. The development of soft ground tunnelling techniques is described including tunnel lining development, tunnel shield and TBM data, operational modes, back up logistics and tunnelling experiences. Tunnel cycle times, progress rates, production statistics and performance monitoring data are also given. U.K.

95-1257

**Overcoming ground difficulties at Tooting Bec.**

R. P. J. CLARKE (Thames Water Utilities) and C. N. P. MACKENZIE

*Proceedings of Institution of Civil Engineers* 1994, 102, Special Issue 2, 60-75

Unique approaches adopted for completing the 1400 m of Thames Water Ring Main tunnel under Tooting Bec common following the inundation of the tunnelling machine with water and silt are described. Planning for recovery and completion of the tunnel is discussed together with the earth pressure balance boring tunnelling machine specifications. Site establishment, ground freezing procedures and shaft construction are described. U.K.

95-1258

**Actual and possible future measures for the rehabilitation and modernization of drinking water pumps**

C. H. LAUX (Sulzer Pumpen AG, Winterthur) and J.

DUMONT

*Water Supply* 1994, 12, No 3/4, 323-336

Small increases in pump efficiency were worthwhile because around 95 per cent of lifetime costs arose from operation. Modern water supply pumps suffered little erosion, deformation of rotor or stator, operated at low velocity and moderate head with little danger of cavitation, and experienced no thermal loads on pump nozzles. However, regular monitoring would reduce maintenance costs, sudden failures, and total downtime, enabling a more accurate store of spare parts to be kept. When efficiency loss was observed, then refurbishing of wear rings, up or downrating of pumps, painting the volute with enamel, and installing a variable speed drive would improve energy efficiency. Monitoring would also reveal mistakes in design causing cavitation and bearing vibration, enabling these to be corrected before damage ensued. Additionally, retrofitted mechanisms reduced maintenance. The financial benefits and costs of some of the remedial measures should be evaluated before implementation. **Germany**

95-1259

**A study of copper corrosion control strategies**

N. QURISHI (Progressive Consulting Engineers, Inc,

Minneapolis, Minn.) and W. SJOLEND

*Public Works* 1994, 125, No 11, 44-45

A 5 month water quality study had been carried out by Brainerd Public Utilities, Minn., to evaluate various options for controlling copper corrosion in drinking water supplies. The chemicals tested included sodium hydroxide, sodium silicate, and ortho/polyphosphate (Calgon). The study also examined the possibility of reducing levels of dissolved oxygen in the water during aeration to reduce copper corrosion. The corrosivity test stand and test procedure are described and results are discussed. Sodium hydroxide was selected for pH adjustment following dissolved oxygen reduction. Several indices had been developed to estimate the water quality conditions needed to predict precipitation of calcium carbonate, including the Calcium Carbonate Precipitation Potential index. **U.S.A.**

95-1260

**Water pipe network - future strategy detection and prevention of external corrosion in Zurich**

B. C. SKARDA (Zurich Water Supply)

*Water Supply* 1994, 12, No 3/4, 139-150

A strategy to minimize external corrosion, the principal water distribution network problem in Zurich, is explained. Zonal assessments



## UNDERGROUND SERVICES

of damaged pipes, maps of soil aggressiveness and susceptibility to settlement, and stray current measurements were carried out. Future strategy was based on securing the financial resources, completing a GIS, gradual completion of a ring main, renewal of mains prone to failure, some mains reinforcement, a programme of stray current reduction, relining of mains where internal corrosion was a problem, and maximal use of trenchless technology. Actual network conditions would be assessed every 20-25 years. Long term financial planning would be based on replacement rates which took account of pressures, water quality, leakage, burst frequency, age of pipe material, construction cost increases, coordination of underground infrastructure, profitability and public image. **Switzerland**

95-1261

### Methods to analyse and to cure water quality problems in distribution systems.

T. van den HOVEN (Kiwa n.v. Research and Consultancy Nieuwegein), D. van der KOOIJ, J. VREIBURG, and H. BRINK. *Water Supply*, 1994, 12, No 3/4, 151-159.

Improved methods for monitoring the release of lead and copper, scaling, turbidity and biological activity in distribution systems are described. Metal dissolution was assessed by test rigs fed with water from the appropriate distribution zone. Turbidity was measured *in situ* by monitoring instruments and related to characteristics such as residence time and flow in the distribution system. The propensity of water to scale pipes and equipment was correlated to the calcium carbonate it precipitated at 90°C. The biological stability of drinking water was estimated from assimilable organic carbon concentration and biofilm formation rate in standard tests. Such measurements indicated the waters liable to cause quality problems. All the methods had proved valuable in addressing operational difficulties in distribution systems. **Netherlands**

95-1262

### Resurrection of an oil town and its water system

C. H. LAWRENCE (Hisk & McFarland, Inc., Santa Barbara, Calif.) and G. L. McFARLAND. *Public Works*, 1994, 125, No 11, 54-55.

The renovation of the water and sewer system previously operated by the Richfield Oil Company in the oil town of New Cuyama, Calif., is described. Because of the depressed economic conditions, water system improvements were made almost on a pay-as-you-go basis. The first step was the replacement of the leaking aluminium supply main from the potable well with PVC and ductile iron pipe. The work also included the addition of a diesel driven fire pump, several fire hydrant upgrades, a 12 in trunk main and various interconnections to boost fire flows. **U.S.A.**

95-1263

### The management perspectives on rehabilitation

J. B. GILBERT

*Water Supply*, 1994, 12, No 3/4, 1-10.

Factors affecting priorities, economics and management of water system rehabilitation are discussed. New techniques were available to assist planning and financing. They included risk and probability analysis of failure, stored data for supporting failure analysis which helped in determining costs, various creative financing methods, and new materials and construction methods. A balance had to be achieved between the demands of water services and other socially important activities. The knowledge and participation of the public should be used in reaching sound investment decisions. **U.S.A.**

95-1264

### Criteria to determine appropriate levels of investment for rehabilitation.

D. W. LACKINGTON (Severn Trent Water, Leicester) and B. L. BURROWS

*Water Supply*, 1994, 12, No 3/4, 21-32.

Factors determining investment in water system rehabilitation in the U.K. are considered with particular reference to Severn Trent Water Limited. The driving force in formulating rehabilitation programmes arose from customer service criteria, governed by the Office of Water Services reference standards, company standards, water quality regulations, obligations of the 1991 Water Act, customer warning rules, and requirements for contractor performance. Various data and monitoring systems provided information on the distribution system which was gathered into a systematic database. An asset management plan then identified lengths of mains needing rehabilitation. These were prioritized in a rehabilitation programme. Options of relining or replacing mains were evaluated, the latter usually chosen where there was leakage, pressure deficiencies or poor structural conditions. The current rate of mains renewal of 1.1 per cent per year in the Severn Trent area was considered low to address water distribution problems at sufficient speed. **U.K.**

95-1265

### Management of materials and construction: technical, organizational and economic aspects

G. MERLO (Azienda Acquedotto Municipale di Torino). *Water Supply*, 1994, 12, No 3/4, 33-42.

Technical, organizational and economic aspects of mains rehabilitation are discussed. The choice between rehabilitation and replacement is evaluated, the selection of materials is debated. Steps in planning the project, awarding the contract and site management are explained. Accurate design addressed to each case, extensive testing and detailed site management were critical. Although correct decision relating to rehabilitation could be difficult, it was an important and cost effective alternative to replacement. **Italy**

95-1266

### Criteria for planning and establishing priorities for distribution network rehabilitation.

W. HIRNER (E.W.A.G. Energie und Wasserversorgung AG, Nürnberg)

*Water Supply*, 1994, 12, No 3/4, 43-58.

The principles of planning distribution system rehabilitation are discussed. The need for improvements arose from failure to meet national and company standards of water quality, pressure, leakage and other levels of service. Network analyses based on maps, can indexes, files, statistics and investigations for individual zones identified areas requiring attention. Technical and economic targets were defined and priorities assigned to those parts of the system requiring attention. Rehabilitation had to be planned as a long term unitary concept. Methods of cleaning, renovation and replacement are described, technical and economic criteria for choosing a particular method explained. The application of the approach to the main network of Nuremberg is outlined. **Germany**

95-1267

### Pipeline rehabilitation - challenges and innovations.

M. J. SLIPPER (WRc plc, Swindon)

*Water Supply*, 1994, 12, No 3/4, 59-67.

Challenges and likely improvements in the field of pipe rehabilitation are discussed. Some of the challenges included increasing consumer

demands for improved quality and greater awareness of environmental issues; regulatory pressure; meeting standards while improving efficiency; involving the private sector; and awareness of new technologies. These challenges would stimulate innovation. A wider use of trenchless technology and the introduction of quality management procedures by contractors were likely developments. Lining with polyethylene pipe materials or fabrics impregnated with epoxy or polyester resins would improve and be more widely used. Improvements were anticipated in most existing techniques in the response to the need to reduce costs, curtail leakage and minimize effects on water quality. **U.K.**

95-1268

## Technologies for pipeline rehabilitation: an overview of drinking water mains rehabilitation.

J. F. BOST (Lyonnaise des Eaux-Dumex, Nanterre, France), P. CHANTRE, A. LOWDEN, and A. MUNKLEY  
*Water Supply*, 1994, 12, No. 3/4, 69-79

Aspects of the renovation of water mains are debated. The choice between renewal and rehabilitation could only be made after gathering detailed information on the network through an assessment procedure. Geographical information systems and associated software were particularly valuable. Simple financial indicators could then identify the correct choice. Rehabilitation coupled with trenchless technology were usually the cheapest options as public works legislation and environmental considerations became more demanding. Quality assurance and customer service would become increasingly important factors in future contractual negotiations. **Europe**

95-1269

## Status and rehabilitation of the distribution network in Dresden.

P. MICHALIK (WAB Dresden GmbH)  
*Water Supply*, 1994, 12, No. 3/4, 81-87

The historical development, the current extent and condition of the Dresden water distribution system are described. Replacement or rehabilitation, currently 17-18 km per year, was to be raised to 30 km per year. Replacement would be principally by cement-lined ductile iron mains externally galvanized and coated with bitumen. Where possible, rehabilitation would be chosen in preference to replacement and cement-mortar lining applied to medium-size iron pipes. Polyethylene pipe insertion would be preferred for the largest mains. With much work also necessary on roads, it was essential to coordinate the highway and water utilities. The programme would also address lead service pipes, leakage and water treatment. **Germany**

95-1270

## Rehabilitation of the water distribution network in the city of Moscow.

A. DYACHKOV (MOSVODOCANAL Municipal Enterprise, Moscow).  
*Water Supply*, 1994, 12, No. 3/4, 89-94

The extent of the Moscow distribution network, its current state and the planning of its rehabilitation are outlined. The decision to renovate was taken on the basis of age, working pressure, pipe material and leakage. Replacement by open trench techniques and rehabilitation by scraping and cement-mortar lining were the principal methods. 25-28 km of pipelines per year were being treated by each method. Cathodic protection was being applied to many iron pipes as a preventive measure. **Russia**

95-1271

## Restoration of a damaged aqueduct in a gallery.

P. MARTINI (River Tiber Authority, Rome)  
*Water Supply*, 1994, 12, No. 3/4, 95-104

The repair of the western tunnel section of the Peschiera aqueduct is described. The collapse was detected by differences in water levels and increases in turbidity. Emergency water supplies were arranged and the repair delayed for 3 months until a time of low demand. After ground and site investigations, a detailed rehabilitation plan was drawn up which involved drilling two 1.2 m diameter access shafts upstream and downstream of the damaged zone, two 0.6 m diameter shafts were also bored for the introduction of concrete. The affected portions were lined with stainless steel sheet, reinforced and concreted. About 200 tonnes of debris were removed in work whose total cost was 600,000 U.S. dollars. The public was kept informed throughout the operation. **Italy**

95-1272

## Technical and economic criteria determining the rehabilitation and/or renewal of drinking water pipelines.

H. HERBERT (Stadtwerke Innsbruck)  
*Water Supply*, 1994, 12, No. 3/4, 105-117

Technical and economic aspects of pipeline renovation or rehabilitation are reviewed from an Austrian viewpoint. The history of water supply networks is outlined. Factors influencing the decision to renew or renovate are explained, among them the technical service life and detailed monitoring data on network conditions. Some of the criteria were those relating to the pipeline, operations, processes, construction, local conditions, implementation of works, and environmental protection. Technical criteria affecting this decision included leakage, lack of pressure, and turbidity, direct and indirect cost savings of alternatives are compared with each other, and with the no action option, as part of the economic evaluation. New technologies would continue to influence decisions. **Austria**

95-1273

## Combined sewer overflow control through in-receiving water storage: an efficiency evaluation.

R. FIELD (U.S. EPA, Edison, N.J.), R. PITT, D. JAGER, and M. BROWN  
*Water Resources Bulletin*, 1994, 30, No. 5, 921-928

A demonstration and efficiency evaluation project was conducted for the flow balancing method (FBM) at Fresh creek, Brooklyn, New York City. The FBM is a combined sewer overflow (CSO) storage facility. The FBM is a curtained tank located directly in the receiving water that captures CSO. The CSO was captured in the FBM by displacing the Fresh creek saltwater in the tank. A statistical basis for the evaluation of FBM efficiency to capture and pumpback CSO for treatment at the treatment works was developed. Specific conductivity and flow volume data were analysed for use as the principal controlling parameters in a mass balance analysis using probability distributions of the known factors. These probability distributions were used in a Monte Carlo simulation model to calculate the probable FBM efficiency. The efficiency was directly related to the volume of the CSO and the pumpback rate and ranged from 3.3 per cent for the largest CSO event up to 76.9 for the smallest event. **U.S.A.**

## UNDERGROUND SERVICES

95-1274

### **Integrated and stochastic features of urban drainage systems.**

P. HARRÉMOIS (Denmark Technical University, Lyngby)

*Water Science & Technology*, 1994, 30, No 1, 1-12

The uncertainty of input parameters to deterministic models was analysed with emphasis on models of sewer systems. The input parameters for deterministic modelling of rain runoff in sewers include rain, degree of paved area, runoff coefficient, Manning number, detailed geometry of structures, wastewater flow, wastewater concentration, runoff concentration. A sensitivity analysis for each parameter and a Monte Carlo analysis of all the parameters were conducted. Models for simulating sewage treatment plants in wet and dry conditions are discussed. An integrated analysis was required to find economically optimized solutions that complied with environmental standards. Online measurements and control would benefit from the development of stochastic models containing features from deterministic models. **Denmark**

95-1275

### **MOUSETRAP - deterministic sewer flow quality model.**

R. CRABTREE (WRc plc, Swindon), H. GARSDALE, R. GENT

O. MARK and J. DORR

*Water Science & Technology*, 1994, 30, No 1, 107-115

A new component called MOUSETRAP, which allows time varying sewer flow and pollutant concentrations to be simulated under wet and dry weather flow conditions, was developed for the MOUSE sewer system hydraulic analysis package by an international consortium of sewer model developers. MOUSETRAP is formed of a series of modules representing surface runoff quality, sediment transport, advection, dispersion, and water quality. There are 3 sediment types in MOUSETRAP: surface sediment, in pipe sediment, and deposited foul flow sediment. The modelling of sediment attached pollutants is based on the use of pollutant partitioning coefficients. Testing and initial applications of MOUSETRAP are described. **U.K.**

95-1276

### **Integral control requirements for sewerage systems**

A. G. CAPODAGLIO (Pavia University)

*Water Science & Technology*, 1994, 30, No 1, 131-138

The requirements for real time control (RTC) of a sewer system are considered. Real time control objectives include hydraulic goals (reduction of flooding in urban areas and avoidance of excessive operation and maintenance costs) and water quality objectives (minimization of untreated overflows, minimization of bottleneck limitations within the treatment plant, stability of treatment processes, minimization of total pollutant discharges). Specific requirements for mathematical tools in RTC include speed of execution, accuracy and confidence, and adaptability. Existing modelling techniques are compared against these requirements. The requirements of a control algorithm includes robustness, implementability, and cost factoring. System integration issues are discussed. **Italy**

95-1277

### **Urban drainage in the 21st century: assessment of new technology on the basis of global material flows.**

M. B. BLICK (Georgia University, Athens, U.S.A.), J. CHEN, A.

J. SAUL and D. BUTLER

*Water Science & Technology*, 1994, 30, No 2, 1-12

Speculation on future urban drainage is attempted in the absence of firm views on likely technological developments, accurate definitions of sustainability, environmental quality, climate change and

social attitudes. The analysis sought an urban drainage scenario which minimized distortion of natural global cycles of some categories of materials. The water carriage system of sewage transport has created regional water pollution. Disposal to land was the most desirable outlet for the products of urban drainage. Present methods of treating carbon and phosphorus bearing materials were consistent with this objective but the treatment of nitrogen-containing material required alternative methods. The role of sulphur-containing materials as agents of unintended interference with other material flow needed consideration. Although the control of synthetic organic compounds and heavy metals at source was desirable, this would only be partly successful, causing problems in land disposal of sludge. It was important to take an integrated view of the problem and accept the constraints posed by existing infrastructure in the short term. **International**

95-1278

### **Face lift.**

K. HAYWARD

*Water & Environment Management*, 1994, No 21, 12-13

A tunnelled sewer, sewage treatment works, and coastal outfall scheme being constructed by Northumbrian Water to handle sewage from Seaham and Dawdon, South of Sunderland, is reported. The towns are former coal mining areas, mining spoil had been dumped onto the beach, whose waters consequently failed the requirements of the EC Bathing Waters Directive. The new scheme, which should rectify the deficiency, entails the construction of an intercept, tunnel sewer, varying in depth below ground level from 5.42 m, to convey sewage to a new treatment works being built on a cliff top on the site of the former Dawdon colliery. Sewage will be pumped up for treatment, half the energy cost of doing so will be recovered by returning the treated sewage to the bottom of the shaft, where it will operate a turbine to produce electricity before discharging to the outfall. This will be installed in a trench at depths of up to 6 m below the beach, as the action of the sea is eroding the mine spoil to a level that suggests that the present black overburden will be washed completely away. Constructional and cost details are included. **U.K.**

95-1279

### **The colmation of leaks in sewer systems during dry weather flow**

W. RAUCH (Innsbruck University) and T. STEIGNER

*Water Science & Technology*, 1994, 30, No 1, 205-210

Leakage from sewer systems is one of the principal sources of diffuse groundwater pollution. Infiltration of water with a high content of solids gives rise to a fast colmation of the porous media bordering the damaged sewer, rapidly reducing the amount of flow. The colmation effect was examined for the leakage of domestic sewage pipes. The volume of infiltrated sewage was high at first and then declined significantly with time. Solids concentration and grain size of the bedding material affected the development of colmation. A steady state flow was reached under all experimental conditions in less than 1 h of infiltration. The flow across the semipervious layer was calculated using Darcy's law. The infiltration of sewage was linearly dependent on the area of the leak and the pressure head. The steady-state leakage factor was estimated as 0.001-0.01 litres per second depending on the solids concentration and grain size. **Austria**

95-1280

**Cured-in-place liner avoids pipeline excavation.**

S. SHELLEY (editor)

*Chemical Engineering*, 1994, 101, No 12, 129

A cured-in-place liner was being used to upgrade the ageing sewers in Houston, Tex., rather than employing excavation and replacement operations. The system employs a polyester felt sleeve that is impregnated with Derakane epoxy vinyl resin from the Dow Chemical Co., Midland, Mich. After the fabric tube, which is available in sizes of up to 120 in in diameter, is winched into position, hydrostatic pressure is used to force it to conform to the uneven surface of the deteriorated sewer pipe walls. Hot water is then used to cure the resin *in situ* so that a pipe-within-a-pipe is formed that adheres to the sewer pipe. An advantage of this system is that it is resistant to corrosion and is durable enough to withstand hydrostatic pressure. U.S.A.

95-1281

**Pipe dreams do come through.**

C. RILEY (Sewer Renovation Federation)

*Contract Journal*, 1994, 376, No 5999, 23-26

The present state of the U.K.'s sewerage infrastructure required early and substantial expenditure to achieve system renovation and avoid replacement. Typical sewer renovation methods are outlined. The underspend in sewer renovation (Infrastructure Renewal Expenditure) over the first 10 factor period had placed the sewer renovation industry under great financial pressures. Much of the development work in sewer renovation had been carried out by smaller companies with limited resources and/or experiences to exploit these developments. Members of the Sewer Renovation Federation were involved in day-to-day inspection, survey, repair and renovation of the existing infrastructure. Financial implications of these renovations are discussed. U.K.

95-1282

**For the first time in France: a method for the rehabilitation of sewer branch pipes.**

E. VANDAMME (Société Entrepose) and A. RACHER

*Ind. Industrie, Nuances*, 1994, No 175, 38-39 (in French, English summary)

In October 1993 the Entrepose company undertook a sewer relining project on behalf of the Paris Sewerage Department, in which 1400 m of 1000 mm diameter sewer was relined using the Insituform method and the branch pipes were also relined from inside the pipe by a robot controlled device for insertion and inflation of a liner inside the branch pipe. The principal sewer was situated in the road at depths ranging from 2.4 to 6.6 m below the surface of the carriage way in the Rue Lyden Dedouart, a narrow street flanked by tall buildings, and the 1000 mm diameter pipe exhibited numerous multiple cracks, joint displacements and other defects. It was relined without difficulty and after curing of the resin, 8 separate lateral connections of approximately 200 mm diameter were also relined by remote control using the Insituform method. A special seal was applied at the point where the lateral joined the principal pipe on completion of the relining process. (English translation 45 pounds sterling, valid for 1995). France

95-1283

**Trenchless point repairs at the Walt Disney World Resort Complex.**

*Public Works*, 1994, 125, No 11, 42

Following problems caused by heavy traffic, sandy soil and a widely fluctuating water table, a detailed diagnostic survey of the sanitary sewer system at the Walt Disney World Resort Complex in Florida

had been carried out. The survey had been conducted by Metro Sewer Services for Reedy Creek Energy Services. An analytical report had been presented of each line section along with repair options. To minimize disruption, trenchless pipe repairs of 15 in Flextran pipes were carried out by Point Repair Liner Services. The repairs used Econoliner flow through packer and epoxy resin-saturated Economat (fibreglass separated by a layer of needled polyester), lowered through a manhole and winched into position in the pipe. The point repair technology allowed the work to be carried out without bypass pumping, thus reducing costs. U.S.A.

95-1284

**Reliability analysis of open drainage channels under multiple failure modes.**

S. M. FASA (Lakehead University, Thunder Bay, Ont.)

*Journal of Irrigation and Drainage Engineering*, 1994, 120, No 6, 1007-1024

A reliability method for analysing open drainage channels over 3 possible failure modes involved computing a reliability index using an iterative procedure and estimating a failure probability for each failure mode using the advanced first order second moment (AFOSM) method. System performance was a random variable due to uncertainty in the component design variables. The first failure mode occurred when runoff (estimated by the rational method) exceeded channel capacity (estimated by the Manning equation). The second failure mode occurred when the actual flow velocity exceeded maximal allowable velocity for erosion control, and the third when actual flow velocity was lower than the minimal allowable velocity for deposition control. Overall system failure probability was related to the failure probability of the individual modes, accounting for correlation between them. Application of the proposed method is illustrated by a hypothetical example in which a trapezoidal cross section was evaluated for runoff accommodation and the prevention of erosion and deposition. Monte Carlo simulation was used to verify the AFOSM method and design variable solution is discussed. Practical applications included evaluation of the effects of existing channel improvement and new channel design to a specified reliability level. Canada

95-1285

**A new streetscape for stormwater management in Mediterranean-climate cities: the concept explored.**

J. R. ARCELT (South Australia University, The Levels)

*Water Science & Technology*, 1994, 30, No 1, 23-35

Adelaide, which has a Mediterranean type climate, depends for its main supply on surface runoff imported from local catchments and the Murray river. There was a trend towards collecting, treating and storing storm runoff in Quaternary and Tertiary aquifers below the city for subsequent nonpotable use. One initiative being undertaken for on-site retention of storm runoff at the New Brompton Estate in Adelaide is described. Roof runoff was piped to a gravel filled stormwater retention trench which contained a bore penetrating the confined sand/gravel Quaternary aquifer 30 m below natural surface level. The bore/aquifer system provided water for surface irrigation in summer and deciduous trees, planted at 6 m intervals along the trench, abstracted water from the moist soil adjacent to the trench principally in summer. The hydraulic and hydrological behaviour of the Swale/trench streetscape system is considered. The new streetscape had the following advantages: reduced peak outflows, improved effluent water quality, greening of the landscape, potential for aquifer recharge, use of aquifer water for irrigation, and reduced risk of flooding. Australia

## UNDERGROUND SERVICES

95-1286

### **Infiltration structures in Tokyo.**

S. FUJITA (Japan Institute of Wastewater Engineering Technology (JIWT) Tokyo)

*Water Science & Technology* 1994, 30, No 1, 33-41

Stormwater infiltration facilities were first implemented in Japan in the 1970s. The principal objectives of stormwater infiltration are discussed: runoff control and groundwater enrichment. The construction, configuration and dimensions of various infiltration facilities are described: permeable asphalt pavements, porous concrete block pavement, soakaways and infiltration inlets, infiltration trench, infiltration L U curbs, storage tanks with infiltration, permeable artificial turf, permeable manholes. By March 1992, 2.3 per cent of the total street area of Tokyo was paved with permeable asphalt. Use of infiltration facilities reduced contamination of waters receiving stormwater runoff. **Japan**

95-1287

### **CSO-masterplan for the city of Waldenburg, Germany.**

S. MICHEL BACH (Umwelt- und Fluid-Technik Dr H. Brombach GmbH, Bad Mergentheim), G. WEISS and H. BROMBACH

*Water Science & Technology* 1994, 30, No 1, 43-52

The combined sewer overflow (CSO) Masterplan for Waldenburg in south Germany was initiated in 1976. Because of new ecological requirements and the availability of new technologies it was decided to revise the plan and in 1991 the company Umwelt- und Fluid-Technik was contracted to conduct an urban hydrological study to develop an alternative approach to stormwater treatment. The existing sewer system and stormwater treatment methods and the water quality of receiving waters were determined in an interdisciplinary field study. Using the water quantity/quality sewer model ASMI, the annual pollution loads for different planning alternatives were determined. The proposed alternative saved 1 million DM and had a lower impact on the environment than the original planned system. This alternative avoided stormwater tanks at locations which were known to be sensitive to a great overflow volume or pollutant load. Combined sewer overflows were used instead. The solution minimized the necessary new total stormwater tank volume. **Germany**

95-1288

### **Design of stormwater infiltration for reduction of combined sewer overflow (CSO)**

C. O. ROSEN D. PETERSEN (Kruger AS, Soborg), P. JACOBSEN and P. S. MIKKELSEN

*Water Science & Technology* 1994, 30, No 1, 53-61

The pollution loads from combined sewer overflows (CSO) are traditionally reduced by building large detention basins to detain the water until there is room in the sewer system. The use of stormwater infiltration reduces stormwater entry to the sewer system. The most commonly used infiltration structures in Denmark are infiltration trenches. It was shown that for a required reduction in CSO volume there was a relation between the volume of the infiltration structure and the size of impermeable area connected to the infiltration structure. An optimal solution minimizing total trench volume was developed. For a Danish sewer system with a travel time of 30 minutes and an interceptor capacity of 0.2 m<sup>3</sup> per second, the yearly overflow volume from the CSO could be reduced by 62 per cent if the drainage area was reduced to 60 per cent of its initial value. **Denmark**

95-1289

### **Gross solids in sewer systems: temporal and catchment based relationships.**

C. JEFFERIES (Dundee Institute of Technology), and R. M. ASHLEY

*Water Science & Technology* 1994, 30, No 1, 63-71

The behaviour of gross and visible solids was studied at 2 combined sewer overflow sites in Dunfermline, Scotland (a stalling pond at Broomhead and a high side weir at Elgin Street) using the Gross Solids Sampler developed by WRC plc. At Elgin Street the variation in dry weather gross solids loads was determined. There was a correlation between the load of gross solids and that of total suspended solids. A chart is presented which differentiates the gross solids production of 2 different types of collector: a collector catchment and a trunk. The rate of gross solids production was a critical factor in differentiating between the catchments. A further differentiation was also derived on the basis of antecedent dry weather period (ADWP) greater than 24 h allowing greater accumulations than shorter drier weather periods. At Broomhead the gross solids concentrations were always higher than suspended solids when the ADWP was greater than 24 h, whereas they were always lower for shorter ADWP. In Elgin Street the gross solids concentrations were with one exception, less than that for suspended solids. **U.K.**

95-1290

### **Computational modelling of a vortex CSO structure**

A. J. SAUL (Sheffield University), and K. SVEJKOVSKY

*Water Science & Technology* 1994, 30, No 1, 97-106

Vortex combined sewer overflow (CSO) structures with a peripheral spill weir are sometimes used in U.K. sewer systems for the prevention of flooding and the retention of pollutants within the sewer system. The Computational Fluid Dynamics package FLUENT was used to simulate the hydraulic performance and the particle retention efficiency of a vortex CSO chamber with a peripheral spill weir. The setting up and operation of the package is described. It consists of 6 steps: definition of domain, physical constants and definition of variables, setting of cells, boundary conditions, simulation of the velocity distribution and calculation of particle trajectories. It was possible to predict the solids separation efficiency for individual particles. The computed flow patterns were similar to those obtained in full scale laboratory tests. Zones of low flow velocity and high upward velocity were observed in the chamber. A spiral shaped scumboard was effective in the development of a central vortex core to the throughflow outlet. The capabilities and limitations of the FLUENT model to predict the hydraulic and pollutant retention performance of a vortex CSO chamber are discussed. **U.K.**

95-1291

### **Process design of advanced storage-treatment facilities for CSO control**

G. ZUKOVY (W2O Inc., Mississauga, Ont.), and W. PISANO

*Water Science & Technology* 1994, 30, No 1, 121-130

Experience gained during a study of high rate combined sewer overflow (CSO) treatment alternatives in Metropolitan Toronto, Canada resulted in the development of systematic planning and preliminary design procedures. The Toronto study examined 6 sub-basins for potential application of satellite treatment facilities. The process design procedure is described and illustrated with data from the Toronto study. The procedure consists of 5 steps: (1) characterization of catchment hydrology and pollutant export and system hydraulics of regulators or overflows, (2) development of a preliminary process flow sheet based on specific CSO process design objectives.

uses: (3) process studies to develop data regarding process applicability and specific unit process efficiency, (4) refinement of process flow sheet and performance analysis of final flowsheet using coupled catchment and process simulation models, (5) determination of control and operational requirements and preparation of preliminary capital and operating cost estimates. **Canada**

95-1292

**Clean start.**

K. HAYWARD

*New Civil Engineer*, 1994, No 1108, 24-26

Work being carried out by Northumbrian Water as part of its bathing water EC compliance programme is described. The 18 million pounds sterling scheme included the pulling of the new long sea outfall at Seaham. The project was being used by Northumbrian Water as a test run for the forthcoming Construction (Design & Management) Regulations which were intended to improve management of health and safety on construction sites. The outfall contract included a 235 m hand dug tunnel from the beach into the cliff face. Steel pipes with an internal urethane pitch coating would be welded together during the pull and would be buried at up to 9 m below the present beach surface. Work was scheduled for completion September 1995. **U.K.**

95-1293

**The Glenridding hydro scheme**

P. HESLOP

*Resource*, 1994, 3, No 1, 15-16

The regeneration of a hydro electricity scheme in the Lake District by the electricity company Norweb is described. At Glenridding near Ullswater, the Greenside lead mine had installed a generator in 1891, the mine closed in 1962, but some useful buildings remained. Norweb, having conducted an economic evaluation of the potential of the site, and being aware that it had an obligation under the Non Fossil Fuel provisions of its privatization terms to foster power generation from renewable energy sources, decided to re-commence generation. This entailed laying a pipeline of more than a mile in length (buried to meet environmental requirements) from the original dam to the generating house; this was reconstructed by local labour using local materials to resemble a typical Lakeland farm building. The station provided electricity to approximately 500 homes via the local network. Other sites and other means of power generation were studied in a joint venture between Norweb and the Energy Technology Support Unit, set up in 1988. **U.K.**

95-1294

**Mooshausen hydroelectric power station. Design and construction of a generating plant for harnessing the minimal discharge of the Iller river**

E. EISELE (Energie Versorgung Schwaben AG, Stuttgart), T.

GERBER, G. ITTL, and K. KALLWITZ

*Wasserwirtschaft*, 1994, 84, No 11, 588-594 (in German, English summary)

The lower reaches of the Iller river have been extensively developed for hydroelectric purposes, with a series of flow regulated channels constructed in parallel with the original course of the river. One of these, with a length of 21 km was a series of 3 generating plants at Tannheim, Unterpfingen and Dettingen, all operated by the Schwaben Energy Supply Company with a combined output of 36 MW. In the interests of maximizing power output, the flow in the old course of the river, which was channelized during the nineteenth century, had been reduced so much that at certain times of the year the water

was stagnant and subject to eutrophication. To counteract this, a vigorous campaign to ensure a guaranteed minimal flow was successful in achieving a legally prescribed minimal flow ranging from 3 m<sup>3</sup> per second in winter to 9 m<sup>3</sup> per second in Spring, to maintain the freshwater biocenosis. The resulting loss of electrical output from the principal generating stations had been partly compensated by the erection of a small generating station at Mooshausen on the original course of the river. The design and construction of this plant with a rated output of 450 kW are described, with photographs of the work in progress. It commenced operation at the end of June 1994 and quickly achieved its rated capacity. It was operated by remote control from the central control room for the Iller power station complex. (English translation 170 pounds sterling valid for 1995). **Germany**

95-1295

**Design and construction of the Langschede plant.**

L. HEUSER (Bjornsen Beratende Ingenieure Darmstadt GmbH) and F. ZIÖR

*Wasserwirtschaft*, 1994, 84, No 11, 596-598 and 600 (in German, English summary)

By the beginning of the twentieth century a hydroelectric plant and its associated weir had been erected on the north bank of the Ruhr at Langschede, with 2 Francis turbines for the supply of electricity to the adjoining steel rolling mills and galvanizing plant. These plants were demolished in the 1960s, leaving only the weir, which was at an angle to the direction of flow of the Ruhr. Toward the end of the 1980s a plan to construct a new hydroelectric plant at this point was proposed by the Municipal Works Department of Frondenberg to supplement the output from 2 other power stations. Following detailed planning and purchase of the original weir, approval for the scheme was granted in November 1991, and work commenced on a new generating station housing 2 Kaplan turbines with a full flow capacity of 20 m<sup>3</sup> per second each, for a normal drop in level of 3.18 m and a total output of 1018 kW. The construction was accomplished in 2 stages, during which the flow of the Ruhr was narrowed to around half its original width and substantial portions of the original weir and bank reinforcement were broken out. The power station is situated on the north bank of the river and its surroundings have been landscaped to render it unobtrusive. Construction work was interrupted by severe floods on 3 occasions. A vertical slot fish pass has been incorporated into the weir structure. (English translation 135 pounds sterling valid for 1995). **Germany**

95-1296

**Hydropower development in China**

P. HAZHENG (Ministry of Energy, Beijing) and Z. JINSHENG

*Water Resources Journal*, 1994, No 180, 75-76

The exploitable hydropower potential in China was assessed and targets for future development briefly reviewed. The total exploitable potential amounted to 378 GW, corresponding to an annual power generation of 1923 TWh. At the end of 1991, the total installed capacity in the country amounted to 156 473 MW of which 37 844 MW came from hydropower stations. This represented only about 10 per cent of the nation's total exploitable potential. The principal technical parameters of large projects under construction or proposed for implementation in the near future are tabulated. The possibility of international participation in future developments is considered. **China**

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95-1297

### **Recent progress in pumped-storage schemes in China.**

C. XUEMIN (China Electricity Council, Beijing)

*Water Resources Journal*, 1994, No 180, 80-83

The contribution of pumped storage projects to Chinese electric power grids was assessed. This type of scheme was initiated in the coastal provinces to meet the large peak power demands there since the mid-1980s. Five pumped storage projects with a total generating capacity of 4332.5 MW were under construction. It was estimated that about 10 GW of pumped storage capacity could be installed in China by the end of the century. The projects at Panjiakou, Guangzhou, Yangzhuyong lake, Ming tombs and Tianhuangping are described. An indication of possible forthcoming projects is also given. **China**

95-1298

### **Learning disaggregation technique for the operation of long-term hydroelectric power systems.**

M. SAAD (Universite de Quebec, Montreal), A. TURGEON, P. BIGRAS, and R. DUQUETTE

*Water Resources Research*, 1994, 30, No 11, 3195-3202

A nonlinear disaggregation technique was developed for the operation of multi-reservoir systems. The method was based on learning from deterministic optimizations. Disaggregation was accomplished by training a neural network to yield, for an aggregated storage level, the storage level of each reservoir of the system. The training set was produced by solving the deterministic operating problem of a large number of equally likely flow sequences. Training used the back-propagation method. The quadratic error was minimized using a variable step gradient method. The technique was applied to the La Grande river in Quebec. The results are compared with those of the principal component analysis disaggregation technique. There are 44 references. **U.S.A.**

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See also Abstracts 95-1151, 95-1173, 95-1174, 95-1175, 95-1215, 95-1225, 95-1230, 95-1277, 95-1430, 95-1441, 95-1444

95-1299

### **Washed and dried.**

M. MUNRO

*Contract Journal*, 1994, 376, No 6000, 34-36

A new sewage treatment works was being constructed in Fleetwood as part of North West Water's Flyde Coastal Water Improvement Scheme, a major project to improve discharged effluent quality. The scheme also included a 1.2 km long interceptor sewer being built by Amec. The 65 million pounds sterling treatment works, being managed by Taylor Woodrow, was being built under a design and build contract awarded to Bachy Ltd. Safe, dry conditions for construction of the inlet were being secured by construction of a 1 m thick, 20 m diameter deep diaphragm wall surrounding the pumping inlet shaft. Construction of this wall is described. The soil foundations below the 42 m deep reinforcement would be injected with grout to provide additional sealing. **U.K.**

95-1300

### **Underground solution for wastewater treatment plant.**

D. WILSON

*Tunnels & Tunnelling*, 1994, 26, No 11, 24-26

The design and construction of a large wastewater treatment works in the Pusteria valley in Alto Adige, Bolzano province, northern Italy, is described. The structure was being located underground to minimize environmental impact and preserve the natural beauty of the alpine valley. Other advantages of the underground structure include minimized impacts of climatic extremes, a shorter construction schedule, controlled environment with economies in running costs and minimal noise and odour pollution. The works comprised a 950 m long, 3.9 m diameter headrace supply tunnel, adjacent side tunnels, chemical purification chambers, anaerobic digestion, a cogeneration process, chemical/biological scrubbing, and dewatering and batching of solids. The civil engineering works using a TBM and boom drilling jumbo are detailed. Work was scheduled for completion at the end of 1995. **Italy**

95-1301

### **A seven year plan for upgrading the 200,000 p.e. treatment plant of Uppsala, Sweden.**

J. E. LIND (JEL Driftassistens, Uppsala), and E. O. SWEDLING

*Water Science & Technology*, 1994, 29, No 12, 117-127

A plan to upgrade the Uppsala sewage works for the next 20-30 years was started in 1987. It addressed 18 items relating to most of the processes in the existing plant. A multidisciplinary team investigated biological nitrogen removal, initiated an extensive programme of monitoring plant performance, and undertook detailed cost breakdowns. Nitrogen removal was to be based on anoxic and aerobic activated sludge; the relative merits of the addition of methanol were examined. Partial implementation of the renewal programme had improved effluent quality and cost-effectiveness. The utilization of biogas would further reduce costs. Additional work would eliminate odours, reconstruct the activated sludge plants and add to existing safety measures. **Sweden**

95-1302

### **Integrated planning of improvements of sewer system and treatment plant for suburbs of Copenhagen.**

O. B. HANSEN (H. Kruger AS, Soborg), and J. PEDERSEN

*Water Science & Technology*, 1994, 30, No 1, 157-166

A study to identify ways of improving the sewer system and the treatment plant in Avedøre, Copenhagen, Denmark is described. Seven alternatives are considered. For each alternative the annual pollution loads from combined sewer overflows (CSO) were calculated using a mathematical model. MOUSE-NAM was selected as the hydrological model to simulate inflows to the sewer system and the MOUSE-PILOT model was selected to simulate the corresponding runoff processes in the sewer system. The necessary extension of the plant was determined with respect to aeration tank capacity and secondary clarifier capacity to comply with stricter effluent criteria. The costs of each alternative were estimated. A plant capacity of 5000 m<sup>3</sup> per h was selected and overflow volumes from the basin to the treatment plant were reduced through real-time control of the sewer system together with elimination/reduction of faulty connections and rehabilitation of the sewer system. **Denmark**

95-1303

**Design and design evaluation of biological wastewater treatment plants.**

H. KROISS (Technology University, Wien)

*Water Science & Technology*, 1994, 30, No 4, 1-6

Problems associated with the design of wastewater treatment plants are discussed. A design procedure is proposed addressing the specific local situation, the required treatment efficiency, process selection, the underlying theoretical principles and the data base required. Design evaluation from experience of full-scale plants is explained. It compares actual loadings, treatment efficiency and mass balances obtained from extensive monitoring with design values and process models using statistical principles. Among the difficulties are a lack of information on how process reliability affects the receiving water, the calculation of benefits, and an absence of international standardization to facilitate widespread comparisons. **Austria**

95-1304

**Wastewater treatment plant operation costs.**

P. BALMER (Goteborg Regional Sewage Works) and B. MATTESSON

*Water Science & Technology*, 1994, 30, No 4, 7-15

Operational and maintenance data were collected for 20 wastewater treatment plants of 5000-500000 population equivalent and low trade effluent loads with similar process configurations and effluent qualities. Primary, secondary and sludge treatments and phosphorus removal were studied. Amounts of chemicals, energy or manpower used were expressed in terms of population equivalent. In general unit consumption fell with increasing plant size, indicating the benefits of scale. **Sweden**

95-1305

**Emerging trends in electrical energy usage at Canadian (Ontario) municipal wastewater treatment facilities and strategies for improving energy efficiency.**

B. EVANS (R.V. Anderson Associates Limited, Toronto, Ont.) and P. LAUGHTON

*Water Science & Technology*, 1994, 30, No 4, 17-23

The major power consumers at 65 sewage works were identified in surveys commissioned by Ontario Hydro. The study took account of increasing demands on wastewater treatment plants from stringent environmental controls. Power was expressed as kWh per year and kWh per m<sup>3</sup>. Aeration, influent and effluent pumping, and dewatering accounted for 42, 20 and 6 per cent of power consumption, respectively. Although in principle aeration control offered considerable savings, most large plants had retrofitted fine bubble aeration and small plants were uneconomical to convert. There seemed little scope for improving the power consumption of dewatering plants because of cake solids requirements. The most promising area was sewage and effluent pumping where increased efficiency seemed possible and little work had been undertaken. **Canada**

95-1306

**Removal of odorous compounds in wastewater by using activated carbon, ozonation and aerated biofilter.**

Y. HWANG (Tokyo University), T. MATSUO, K. HANAKI and N. SUZUKI

*Water Research*, 1994, 28, No 11, 2309-2319

Methods of removing sulphur- and nitrogen-containing odorous compounds from solutions of secondary effluent were investigated in the laboratory. The compounds were analysed by gas chromatography. Activated carbon was very effective for the removal of

sulphur compounds, but breakthrough of amines was much swifter. The sulphur-containing compounds were swiftly oxidized by ozone while the reaction with low aliphatic amines was slow. The likely product of methyl mercaptan oxidation was methane sulphonie acid, trimethylamine was converted to nitromethane. An acclimatized aerated biofilter removed more than 80 per cent of both types of compound in a hydraulic retention time of 30 minutes. This method was preferred as it produced none of the partially oxidized compounds resulting from ozonation and had a similarly high removal efficiency for both types of compounds. **Japan**

95-1307

**In-sewer oxygenation of wastewater using venturi side-stream dissolvers.**

G. A. HOLDER (Monash University, Melbourne) and J. M. FLEW

*Water Science & Technology*, 1994, 30, No 1, 185-194

Venturi nozzle oxygen injection facilities were installed for *in situ* sewer oxygenation as part of an odour control strategy for a 100 km length of sewer (the Latrobe Valley Outfall Sewer). Substantial amounts of injected oxygen were lost to the atmosphere. The oxygenation process was studied in the laboratory and field to optimize the efficiencies of the existing field installations and to achieve cost savings. The effects of oxygen dosage and nozzle diameter were determined. There was a trade-off between oxygen costs and mixing energy efficiency. The total operating cost could be minimized by operating at high mass transfer efficiency where oxygen wastage was low. The best way to reduce oxygen wastage was to operate at maximal absorption efficiency with a relatively small diameter nozzle and adequate nozzle pressure loss. **Australia**

95-1308

**Sewer system odour control in the lake Balaton area.**

A. JOBBAGY (Budapest Technical University), I. SZANTO, G. I. VARGA and J. SIMON

*Water Science & Technology*, 1994, 30, No 1, 195-204

Odour problems associated with the sewer system around Balaton lake, Hungary, are described. Nitrate addition was theoretically shown to repress sulphate reduction and hydrogen sulphide production. A model experiment was conducted to determine the influences, advantages and disadvantages of nitrate dosing. Inappropriate dosing could initiate undesired attached microbial growth, denitrification and subsequent sludge loss in the secondary clarifier. A system specific nitrate addition procedure was developed on the basis of the model study. Nitrate overdosing was avoided by an optimal arrangement of the dosing stations. Nitrate addition proved very effective in repressing hydrogen sulphide production. **Hungary**

95-1309

**Odour emissions of wastewater treatment plants - recent German experiences.**

F. B. FRIEHE (Hydro-Ingenieur, Düsseldorf)

*Water Science & Technology*, 1994, 30, No 4, 35-46

Problems of odours at sewage works are discussed. Methods of measuring odour in terms of type, strength, intensity and concentration are considered including mass spectrometry and olfactometry. Special considerations include the odour source, its transmission and quantification of the standards to be met. The general strategies to combat odour nuisance, including reduction, enhanced degradation or adsorption, avoidance of odour formation and restricted emission, are explored. Biological, chemical and physical techniques of odour removal are explained and the relative use of these techniques in



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Germany tabulated. Hydrogen sulphide is recommended as a reference odorant for olfactometry. Multistage deodorization is recommended as the most effective approach to odour control. Germany

95-1310

**Comparison of single mechanism and multi mechanism-based approaches for kinetics of sediment removal.**

R. S. GOVINDARAJU (Kansas State University, Manhattan), P. L. SHRESTHA, and G. T. ORLOB

*Environmental Technology*, 1994, 15, No 12, 1101-1120

A modification of the Farley-Morel approach for modelling cohesive particle sedimentation in aquatic environments incorporated the known physics of sediment removal into an analytical information-based model using power law representations of removal mechanisms. A single aggregation mechanism was assumed to determine sedimentation kinetics over a discrete concentration range. A smooth curve was constructed through concentration versus time data points and the coefficients and exponents required for the inverse problem of parameter estimation were evaluated by the graphical method. Model performance demonstrated reasonable agreement with published experimental data with good prediction of different cases of sediment removal. The proposed analytical model was more versatile than previous models and was applicable to a wide range of concentrations and fluid-sediment environments. U.S.A.

95-1311

**Modelling of full-scale wastewater treatment plants: how detailed should it be?**

B. WATSON (Hydromantis Inc., Hamilton, Ont.), M. RUPKE, I. TAKACS, and G. PATRY

*Water Science & Technology*, 1994, 30, No 2, 141-147

Aspects of modelling wastewater treatment plants were explored with the help of a previously published dynamic modelling package. Four cases of model simplification were examined: aggregated and distributed models, biological activity in the secondary clarifiers compared with no activity, 1-dimensional compared with a 2-dimensional secondary clarifier model, and the numbers of tanks in series for plug flow modelling. There was no general rule or optimal level of modelling. The detail required was a function of influent flow, loading levels, and the processes to be simulated. The supportable modelling level was often constrained by data availability and reliability. A reasonable compromise was a 1-dimensional non-reactive secondary clarifier model with the aeration basin represented by no more than 8 tanks in series. Canada

95-1312

**Stirring and aeration system for the upgrading of small waste water treatment plants.**

M. HOFKEN (Friedrich-Alexander-University, Erlangen), K. ZÄHRINGER, and F. BISCHOF

*Water Science & Technology*, 1994, 29, No 12, 149-156

A stirrer was designed to provide mixing alone or in combination with aeration. Its requirements in the non-aeration mode were gentle circulation and no floc destruction; for aeration they were fast mixing, high oxygen transfer, low aerosol emission and low energy consumption. The characteristics of the flow conditions to achieve these objectives were: symmetrical distribution of streamlines, low energy input at the surface but high input at the bottom, high bottom and wall velocities, input of a different phase at a location of high turbulence, stationary flow conditions, and no separation of flow on the stirrer surface. Calculation of streamlines by potential flow

theory yielded an innovative hyperboloid design of a bottom-mounted stirrer body. The resulting equipment proved flexible and met its specification. Germany

95-1313

**Joint consideration of sewerage system and wastewater treatment plant.**

R. OTTERPOHL (RWTH Aachen), M. FREUND, J. P. SANZ, and A. DURCHSCHLAG

*Water Science & Technology*, 1994, 30, No 1, 147-155

The efficiencies of sewerage systems with storage basins and wastewater treatment plants need to be considered in combination to judge their total effects on receiving waters. The effects of combined water flows on wastewater treatment plants were determined. Computer simulations were conducted of the operation of the sewerage system and wastewater treatment plant under different rain events. The 2 systems were simulated individually. Hydrographs of different scenarios computed for the sewerage system could be used for wastewater treatment plant simulations. Germany

95-1314

**Evaluation of modelling techniques for wastewater treatment plant automation.**

A. G. CAPODAGLIO (Pavia University)

*Water Science & Technology*, 1994, 30, No 2, 149-156

Modelling methodologies relating to wastewater treatment plant operation and other factors are examined to assess their value in supporting automation systems. Stochastic, neural network, and expert system models are considered. All were promising, stochastic models being the most developed and expert systems very expensive. Real-time control also required an extensive network of reliable sensors. The timescale for various processes to respond to changes in input variables was critical to the design of control systems which had to be operated simultaneously at different timescales. The selection of the appropriate process model would depend on availability of adequate monitoring hardware, existing knowledge of the process, ease of model adaptation and computational requirements. Italy

95-1315

**Applied off-line expert system for effluent, operational and technical problems of waste water treatment plants.**

G. LADIGES (Technische Universität Braunschweig) and R. KAYSER

*Water Science & Technology*, 1994, 30, No 2, 157-164

An expert system mounted on a personal computer was applied to the operation of a nutrient removing activated sludge plant. Several knowledge bases concerned wastewater problems and others the formulation of an operational manual. Engineers and operational staff cooperatively produced the 22 knowledge bases. Those concerning wastewater problems dealt with aeration tank control, sludge bulking and effluent quality. The manual addressed individual sections of the plant. The knowledge bases were linked by models and algorithms to form a total expert system. This would be applied to a further plant in the near future. The decision tree in the knowledge base for high effluent ammonia values is illustrated. Germany

95-1316

**Optimizing operation of wastewater treatment plants by off-line and online computer simulation.**

R. OTTERPOHL (RWTH Aachen), T. ROLFS, and J. LONDONG

*Water Science & Technology*, 1994, 30, No 2, 165-174

Computer simulation of wastewater treatment plants is discussed. A flexible simulator was first required on which to build a detailed program representing plant operation. SIMPLEX II was chosen and a library of models of waste treatment plants called ARASIM. If sufficient data were available from automatic sensors and analysers then both on-line and off-line simulations were possible which would optimize operation. The latter enabled several alternatives to be evaluated and the operation of the plant optimized. The value of the approach was only fully realized with careful implementation of the models and characterization of the wastewater. Germany

95-1317

**A knowledge-based decision support system for selecting small-scale wastewater treatment processes.**

T. OKUBO (Tokyo University of Agriculture and Technology), K. KUBO, M. HOSOMI, and A. MURAKAMI

*Water Science & Technology*, 1994, 30, No 2, 175-184

The selection of the most appropriate wastewater treatment plant processes with cost constraints for a given population was made with a personal computer decision support system. This contained a numerical database of treatment performance and cost, a knowledge base for less tangible and empirical information, an analysis module for determining effluent qualities and costs, and a dialogue model for controlling user input and subsequent system output. The output provided effluent water quality, construction, operational and maintenance (O and M) costs, a ranking of O and M difficulty, and other non-numerical parameters. The user could sort the resulting list according to parameter values or ranking score, and prioritize several treatment processes. The system was also able to evaluate plants which included natural purification processes such as a wetland area. Japan

95-1318

**Screening of chemical spill risks to municipal sewage treatment plants**

M. ETTLA (Kuopio University, Salpakangas) and E. ROSSI

*Water Science & Technology*, 1994, 30, No 4, 25-34

A method of screening chemical risks to sewage works was developed following the results of a questionnaire to Scandinavian waste water treatment authorities which revealed 7 serious chemical pillages to sewage works. Operational risks were defined in 7 phases: plant specification, estimation of threshold inhibitory concentrations, classification of potential spill sources, field survey, calculation of threshold quantities, supplementary analyses of waste water, and general proposals. Inhibition of carbonaceous, nitrification, methanogenic and sludge treatment processes are considered. Two sewage works and 11 industrial sites were selected for field studies. A 1-2 h visit was sufficient in most factories for assessing the potential for creating serious chemical spills to the treatment works. Cases were also identified in which failure of industrial pretreatment facilities would cause severe inhibition of biological processes at the receiving sewage works. The method required data on the sewage treatment processes, spill sources and their chemical processes. Likely spill concentrations were then estimated by dilution calculations and continuous release fate models. Finland

95-1319

**Using pH as a real-time control parameter for wastewater treatment and sludge digestion processes.**

I. A. AL GHUSAIN (Kuwait University, Safat), J. HUANG, O. J. HAO, and B. Y. LIM

*Water Science & Technology*, 1994, 30, No 4, 159-168

The control of the alternating aerobic-anoxic process for wastewater treatment and sludge digestion was automated and monitored by a data acquisition and control system. Activated sludge was rendered anoxic by the passage of nitrogen in place of air. The behaviour of pH was compared with that of oxidation-reduction potential (ORP). For sludge digestion, pH fell in the aerobic phase as ammonia was oxidized and then levelled off at a point corresponding to maximal ORP. When anoxic conditions were imposed, pH rose close to 8, coinciding with a short accelerated fall of ORP. With wastewater treatment, the pH and ORP fluctuated within narrower limits. The control of the process by pH measurement was feasible, the best means of detecting the critical points being to differentiate the signal with respect to time. However, set points of pH 6 and 8 were adequate for sludge digestion. These had saved 48 per cent of aeration energy and reduced mixed liquor volatile solids and total nitrogen by 36-49 per cent. U.S.A.

95-1320

**Use of lime for the upgrading of existing wastewater treatment systems**

C. GULDNER (Technische Universität Berlin), W. HEGEMANN, N. PESCHEN, and K. SCHITZ

*Water Science & Technology*, 1994, 29, No 12, 279-282

The performance of an overloaded sewage works was improved by the addition of quicklime before primary sedimentation. This reduced the load on the aeration unit, allowing nitrification to take place. Inadequate carbon levels prevented denitrification. This was corrected by an aerobic digestion of the sludge for 1-2 d, a process yielding volatile fatty acids which were fed to the denitrification stage. The volume of surplus sludge did not increase because lime conditioning, although generating more solids, yielded sludge of superior quality. Germany

95-1321

**'Bioadditives' used to assist fat removal in sewage treatment plants**

P. CHAPPEL (Université de Nancy), A. MOIRAY, and J. MANEM

*Techniques Sciences Methodes*, 1994, 89, No 10, 568-571 (in French)

Four different bioadditives available commercially for enhancing the removal of fat and grease during the biological treatment of sewage were investigated. 2 consisted of liquid preparations enriched with nutrients, and the remaining 2 were freeze-dried powders. Counts of mesophilic aerobic organisms and lipolytic strains of bacteria were performed after incubation on nutrient media, and after isolation of the lipolytic strains the most active were identified. These were cultivated on media containing fatty acids of different chain lengths. Those gram-negative strains which were isolated were able to perform hydrolysis and subsequent beta-oxidation of fatty acids. Gram-positive organisms however were mostly inhibited or destroyed in the presence of fatty acids. Their activity was therefore limited to hydrolysis and their survival for any length of time under practical conditions is very questionable. For successful application of supplements of this type (which have given very variable results in practice) a prior test of their activity and compatibility with the

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substrates they are designed to metabolize is indispensable. It is probable that the normal bioecoenosis would be equally effective following a period of acclimatization to fatty materials. (English translation 120 pounds sterling valid for 1995) **France**

### 95-1322

#### **Critical process design issues in the selection of the TF/SC process for a large secondary treatment plant.**

D. PARKER (Brown and Caldwell Consultants, Walnut Creek, Calif.), S. KRUGLI, and H. McCONNELL.

*Water Science & Technology*, 1994, 29, No 10/11, 209-215

Process evaluation for the upgrading of the Annacis Island wastewater treatment facility, Vancouver, Canada, from primary to secondary treatment involved detailed examination of the oxygen activated sludge process, the air activated sludge process and the trickling filter/solids contact (TF/SC) process. The comprehensive analysis of alternatives covered process designs, works layouts and construction cost estimates. Operation and maintenance costs, including energy and chemical use, were also estimated. The TF/SC process was selected on the basis of lower present value and operating costs, ease of operation, robustness and lower energy costs. **USA**

### 95-1323

#### **Upgrading of wastewater treatment plants to achieve advanced standards concerning nutrient removal**

S. BUSS (Ingenieurburo Buss und Hempel, Bad Schwartau), J. LINDELDE, H. GÜNTHER, and T. WERNER.

*Water Science & Technology*, 1994, 29, No 12, 49-58

Four examples are provided of extensions to wastewater treatment plants of population equivalent 43 000-640 000 to achieve total nitrogen and phosphorus effluent limits of 10-18 and 0.5-2.0 mg per litre, respectively. Existing installations, available land for expansion, and pollution loads were first documented, then laboratory and pilot plant studies were undertaken to provide design data for extensions. Multiple stage and split flow treatments were the most promising general solutions to advanced treatment. In some cases abandoned plant could be re-activated. The solutions for each wastewater treatment works are described. **Germany**

### 95-1324

#### **Process optimization for simultaneous biological nitrification and chemical phosphorus removal**

P. J. BLISS (New South Wales University, Kensington), E. R. OSTARCZUK, and A. A. POTTER.

*Water Science & Technology*, 1994, 29, No 12, 107-115

The optimization of 2 rather disparate processes of nutrient removal was studied by a program which addressed detailed plant operations, priorities of important areas of concern, their detailed monitoring, review of performance, and establishment of optimized parameters. This structured approach identified deficiencies and enabled solutions to be formulated and implemented. Many improvements were made in the maintenance of dissolved oxygen levels, residual alkalinity, pH and flow distribution. These measures reduced mean effluent ammoniacal nitrogen from 4.5 to 0.6 mg per litre. Re-location of the spent pickle liquor feed prior to the pre-aeration basin improved mean total effluent phosphorus and orthophosphate concentrations from 1.0 and 0.9 to 0.6 and 0.5 mg per litre, respectively. **Australia**

### 95-1325

#### **Validation of a new model for biological nutrient removal.**

A. POLLICE (Politecnico di Milano), and R. CANZIANI.

*European Water Pollution Control*, 1994, 4, No 6, 20-29

A model of biological nutrient removal was developed by assuming that polyhydroxybutyrate released from decaying phosphorus-accumulating bacteria (PAB) was accounted for as slowly-degrading COD, that the hydrolysis coefficient of the slowly-degrading organic substrate was higher than the value adopted by the IAWPRC Task Group, that predation was only a minor cause of the death of PAB, and that acetate emerging from the anaerobic reactor was treated as readily-degradable COD in the subsequent reactor. The model required a total of 46 input parameters relating to the process configuration, the major hydraulic components, influent concentrations and the biological processes. Mass balances were described by a set of 54 parametric non-linear equations which were solved by a FORTRAN program. Data were obtained from a pilot plant with anaerobic, anoxic and aerobic components in series according to the Cape Town University configuration fed with a mixture of domestic and industrial wastewater. A high sludge age was maintained for 100 d. Reasonable agreement was obtained between experimental and calculated results despite wide variations in the strength of the influent. Further validation was planned. **Italy**

### 95-1326

#### **Applying entrapped mixed microbial cell techniques for biological wastewater treatment**

P. Y. YANG (Hawaii University at Manoa, Honolulu), T. MA, T. S. SEE, and N. NITISORAVUT.

*Water Science & Technology*, 1994, 29, No 10/11, 487-495

The application of entrapped cell mixed culture systems to the treatment of wastewater was investigated. Various gel polymer were tested as potential carriers. Cellulose triacetate provided the necessary mechanical strength and durability in both aerobic and anaerobic conditions. The substrates treated included glucose, phenol, carbaryl and nitrate. The system studied had a short start-up period and produced high quality effluents in terms of COD, nitrate, nitrogen and suspended solids concentrations. A high solids retention time was combined with a low hydraulic retention time. The development of pre-engineered package systems exploiting this technology is discussed. **USA**

### 95-1327

#### **An improved small sewage treatment plant for biological purification of wastewater.**

G. VOIGTLANDER (University HAB Weimar), and E. P. KUHLE.

*Water Science & Technology*, 1994, 29, No 12, 23-29

A pilot package sewage treatment plant, consisting of a sedimentation tank, anaerobic reactor and a wastewater pond or aerobic reactor, was investigated. Suspended glass fibre surfaces were included in the anaerobic unit to support bacteria and improve the efficiency of this stage. An aerobic unit in which biofilm was supported on doubled sided plastic film permitted oxygen diffusion, proved unsuccessful. An aerobic pond or conventional aerobic system satisfactorily treated the effluent from the anaerobic stage. The significant advantage of the arrangement was the enhanced anaerobic stage which was greatly superior to a septic tank. **Germany**

95-1328

**Upgrading to nutrient removal by means of internal carbon from sludge hydrolysis.**

J. P. BRINCH (I Kruger Systems AS, Søborg, Denmark), K. RINDEL and K. KALB

*Water Science & Technology*, 1994, 29, No 12, 31-40

Organic carbon for nutrient removal was generated by the biological hydrolysis of primary sludge. A residence time of 2-3 d at 25°C stopped anaerobic digestion at the acetogenic phase. The hydrolysate was added to a side stream anaerobic tank where it was mixed with return activated sludge. This compensated for low carbon/phosphorus and carbon/nitrogen ratios in the influent. The process studied at 2 full scale plants proved viable. Denitrification rate was increased by 44 per cent and a final phosphorus concentration of 0.5 mg per litre was consistently achieved. U.S.A.

95-1329

**Biological nutrient removal applied to weak sewage**

J. CHARTON (Carl Bro, Århus Glostrup)

*Water Science & Technology*, 1994, 29, No 12, 41-48

Biological nutrient removal from a wastewater of BOD, total nitrogen and total phosphorus of 133, 140, 29, 30 and 9.0, 9.3 mg per litre respectively was carried out by a full scale modified Cape Town University process. The modifications included a primary sludge digester which enriched the volatile fatty acid contribution to the influent. The latter consisted of anaerobic, 2 anoxic and aerobic zones with aerobic and denitrification recycles. The organic carbon from a sludge fermenter ensured efficient operation, enabling BOD, total nitrogen and total phosphorus concentrations of 15, 8 and 1.5 mg per litre respectively to be met despite the unusually weak sewage. Denmark.

95-1330

**NDBI-PR process optimization in SBRs: reduction of external carbon source and oxygen supply**

C. DEMUYNCK (Gent University), P. VANROLLEGHEM, C. MINGNAAL, J. THIESSENS and W. VERSTRAETE

*Water Science & Technology*, 1994, 30, No 4, 169-179

A sequencing batch reactor (SBR) pilot plant for BOD and nutrient removal was optimized by the Nitrification Denitrification Biological Phosphorus Removal (NDBI-PR) model of Wentzel and Marud's algorithm. The model was calibrated with experimental data from a SBR cycle then used to find an optimal process schedule aimed at economic operation, minimizing effluent COD, ammonia, oxidized nitrogen and phosphorus, and the use of supplementary COD for denitrification. A sequence of short aerobic, anoxic phases was better than the usual sequence of macrobenthic phase followed by an anoxic phase. Supplemental COD was reduced by 50 per cent and aeration time by 30 per cent without detriment to phosphorus removal. Further investigations indicated that the ideal SBR time scheduling probably depended on loading, suggesting that a control strategy by oxygen uptake rate and oxidation reduction potential was viable. Belgium.

95-1331

**Interaction between computer simulations and control using on-line nitrogen measurements**

D. E. THORNBURG (I Kruger Systems, Søborg) and H. A. THOMSEN

*Water Science & Technology*, 1994, 30, No 4, 199-206

The simulation of a biological nitrogen removal (BNR) plant was undertaken with EFOR Version 2.2, a program based on the

IAWPRC activated sludge model No 1 supplemented with models of the secondary clarifier and phosphorus precipitation. The model was applied together with on line measurement of dissolved oxygen, ammonia, nitrate and phosphate concentrations to the optimization of a BNR plant which employed recirculation and simultaneous precipitation of phosphorus. The preparatory work involved finding a realistic sludge concentration, carrying out an uncalibrated simulation, estimating the influent on the basis of ammonia measurements, and calibrating the process constants from on line measurements and the calculated influent. Further simulations and comparisons with on line data refined the parameters. Different control strategies were then evaluated to give optimal effluent quality and energy consumption. Denmark.

95-1332

**Upgrading of a wastewater treatment plant utilizing existing trickling filters and a new filter stage**

M. FRUHN (Institut für Siedlungswasserwirtschaft der RWTH Aachen), W. KUHN and M. DOHMANN

*Water Science & Technology*, 1994, 29, No 12, 59-67

Three options for the upgrading of a sewage works to enhance nutrient removal are considered. These involved nitrification and denitrification in a single stage activated sludge plant with primary sedimentation, in a 2 stage activated sludge plant with residual denitrification in the existing filter, or in a 2 stage activated sludge plant with residual nitrification in downstream trickling filters and residual denitrification in the existing filter. The last alternative was selected. The size of the activated sludge unit was kept to a minimum by incorporating a highly loaded biological treatment before the primary sedimentation tank, thus reducing loads on subsequent stages. Although this made the BOD/nitrogen ratio unfavourable in the activated sludge, further denitrification in the final filter could be encouraged by methanol addition. Germany.

95-1333

**Conventional and unconventional integration of trickling filters in a process for biological nutrient removal**

N. DICHTE (GKI mbH Bochum), N. ENGELHARDT, W. LIRK and F. KOTTUSCH

*Water Science & Technology*, 1994, 29, No 12, 81-88

A sewage works serving an ultimate population equivalent of 140 000 was extended to meet standards of total phosphorus, ammonia, nitrogen and organic nitrogen of 1, 5 and 18 mg per litre respectively. Among the design constraints were integration with relatively recent extensions of the trickling filters, the use of the works as a central sludge drying facility, space constraints, and the need to avoid disruption of treatment. Many alternatives were considered using technical feasibility, purification efficiency, operational safety, consumption of chemicals, investments and running costs as selection criteria. The final solution was a 2 stage denitrification/nitrification activated sludge plant followed by a flocculation filter. Germany.

95-1334

**Practical experience with combined carbon oxidation and nitrification in plastic media trickling filters**

G. T. DAIGER (CH2M HILL, Denver, Colorado), A. HEINEMANN, G. LAND and R. S. WATSON

*Water Science & Technology*, 1994, 29, No 10/11, 189-196

Carbon oxidation and nitrification achieved by 4 full scale trickling filter installations was monitored for several years. The results suggested that a consistent relationship based on carbon and ammo-

## SEWAGE

nia-nitrogen oxidation could be developed to account for the performance of trickling filters treating a wide variety of wastewater types. A single parameter referred to as the volumetric oxidation rate and expressed in kg of oxygen per m<sup>3</sup>.d characterized performance across a wide range of process loading and effluent quality conditions. The analysis used differed from that conventionally used to characterize combined carbon oxidation and nitrification in trickling filters and suggested that oxidation might be limited by oxygen transfer in this type of system. U.S.A.

### 95-1335

#### **Assessment of aerated biofiltration at industrial scale.**

B. KLEIBER (O.T.V., Courbevoie), G. ROUDON, B. BIGOT, and J. SIBONY.

*Water Science & Technology*, 1994, **29**, No.10/11, 197-208.

Biological aerated filters were studied with respect to various operating parameters, including process air supply, energy consumption, sludge production and cycle duration. These factors were studied in medium and large full-sized operating systems, mainly in France. The results from these studies allowed the design and operation of the process to be optimized, and also made it possible to develop very large biofilter installations. Examples of systems treating flows in excess of 50,000 m<sup>3</sup> per d and designed to achieve low nitrogen residuals are considered. Results presented include values from a nitrifying Biocarbone unit in the U.K. and a nitrifying/denitrifying system in Denmark. France

### 95-1336

#### **High rate aerated biofilters for plant upgrading.**

F. ROGALLA (Compagnie General des Eaux/OTV, Maisons Laiffite), A. LAMOUCHE, W. SPECHT, and B. KLEIBER

*Water Science & Technology*, 1994, **29**, No.12, 207-216

The application of the Biocarbone aerated biofilter and its derivatives to sewage treatment are described. The system was similar to conventional rapid sand filters except that air was introduced into the lower portions and a coarser medium was used. Aerobic degradation and clarification were achieved in one reactor whose compactness made it particularly suitable for sensitive environmental areas where land was restricted and odour control essential. A nitrified effluent could often be obtained with a retention time below 2 h. Effluent of 10, 10 and 1 mg per litre for BOD, suspended solids and ammoniacal-nitrogen, respectively were obtainable. The addition of an anoxic biofilter could produce a denitrified effluent. A development using floating polystyrene media as biomass carrier in an upflow system had been developed which allowed a lower anoxic zone in which nitrate from recycled effluent brought about anoxic carbon degradation. Phosphorus removal was also possible. There are 35 references. France

### 95-1337

#### **The treatment trilogy of floating filters: from pilot to prototype to plant.**

H. TOFTTRUP (Denmark Technical University, Lyngby), F. ROGALLA, A. VIDAL, and P. HARREMOES

*Water Science & Technology*, 1994, **29**, No.10/11, 23-32

The kinetics and operational limiting factors of biofilm reactors were investigated at small scale. The accuracy of the method used was verified by comparing the results with those from large-scale reactors. Observed relationships with laboratory reactors using granular floating media conformed to theoretical expectations and half-order kinetics. Major process constants for nitrification were established. Similar kinetics were observed on a full-scale floating aerated biofil-

ter which could be used for complete nitrogen removal from settled wastewater in a single reactor. In implementation at full-scale, nitrogen residuals below 8 mg total nitrogen per litre were achieved. Denmark

### 95-1338

#### **Biofilters: flexible, reliable biological reactors.**

R. PUJOL (Degremont Recherche, Le Pecq), M. HAMON, X. KANDEL, and H. LEMMEL

*Water Science & Technology*, 1994, **29**, No.10/11, 33-38

Knowledge acquired in the operation of Biofor upflow biofiltration reactors was reviewed. More than 50 units using this process were in operation worldwide, representing a population equivalent of several million. Both municipal and industrial treatment systems are included. Results achieved, operating parameters and treatment limitations with respect to the removal of COD, nitrogen and phosphorus are summarized. Present operating limits are defined as loadings of 10 kg COD per m<sup>3</sup>.d, 1.5 kg ammonium nitrogen per m<sup>3</sup>.d for nitrification, up to 4 kg nitrate nitrogen per m<sup>3</sup>.d for denitrification, and 0.4 kg total phosphorus per m<sup>3</sup>.d for phosphorus removal. France

### 95-1339

#### **First months operation of two biofilter prototypes in the waste water plant of Acheres.**

B. VEDRY (Syndicat Interdepartemental pour l'Assainissement de l'Agglomeration Parisienne, Colombes), C. PAFFONI, M. GOUSAILLES, and C. BERNARD

*Water Science & Technology*, 1994, **29**, No.10/11, 39-46

Prototypes of 2 upflow biofiltration systems, Biofor and Biostyr, were built at the Acheres sewage treatment works, Paris, to establish the suitability of this type of process for use as a tertiary treatment stage. The intention was to nitrify and polish secondary effluents to reduce ammonia pollution impacts on the Seine river. The Biofor prototype demonstrated an ammonium nitrogen removal of 0.8 kg per m<sup>3</sup>.d at a temperature of 14°C. The Biostyr prototype was brought into service later and initial results, though promising, were not sufficient to draw firm conclusions. Both systems seemed capable of nitrification throughout the year and able to accept peak loadings and high flow rates. France

### 95-1340

#### **High rate nitrifying trickling filters.**

B. ANDERSSON (Malmo Water and Sewage Works), H. ASPEGREN, D. S. PARKER, and M. P. LUTZ

*Water Science & Technology*, 1994, **29**, No.10/11, 47-52

A nitrifying trickling filter process was evaluated at pilot scale during a 2-year period at the Sjolunda sewage treatment works, Malmo. Filter operation was very stable and was not subject to process upsets due to predators. The filter microfauna was dominated by worms. Numbers of filter fly larvae were limited. Recommended predator control methods such as flooding or varying the flushing intensity did not affect the process microfauna. Operating the system in a 2-stage alternating series mode allowed higher nitrification rates and lower effluent ammonia levels to be achieved than with a single-stage filtration mode. Sweden

95-1341

**Tertiary nitrification in aerated pilot biofilters.**

M. TSCHÜT (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf), M. BOLLER, W. CALDER, J. EUGSTER, C. MADER, and C. STENGEL

*Water Science & Technology*, 1994, 29, No 10/11, 53-60

Three types of aerated biofilters, Biocarbon, Biostyr and Biopur, were operated as pilot scale tertiary nitrification systems. Their long term performance was evaluated in various operating conditions and maximal volumetric nitrification rates in non ammonium limiting conditions were established for each system. An exponential relationship enabling nitrification rates at specified temperatures to be predicted was established. Higher velocities of both air and water in the filter increased the nitrification rate, though they also increased the head loss and lowered the filter run time. Optimal operating conditions were therefore affected by the filter media and the required effluent quality. **Switzerland**

95-1342

**Tertiary nitrification in pilot-plant plug-flow fixed-film reactors with long-term ammonium deficiency**

M. TRUHN (Institut für Siedlungswasserwirtschaft, Aachen), K. BÖCKLER, S. EIDENS, D. HAAE, M. LIEBESKIND, and F. SCHMIDT

*Water Science & Technology*, 1994, 29, No 10/11, 61-67

The extent to which the nitrification capacity of a pilot scale fixed film reactor varied during extensive periods of nutrient supply deficiency was investigated. The pilot plant studied was an upflow reactor filled with swelling clay with a grain size of 0.8 mm. The maximal nitrification rate remained virtually unchanged for some weeks after the onset of unregulated ammonium supply, only slowly dropping to around 66 per cent of the initial capacity after about 10 weeks. The reduction in nitrification capacity resulted from reactor clogging which hindered transfer processes. The study demonstrated the effectiveness of a plug flow fixed film reactor as a method of tertiary nitrification. **Germany**

95-1343

**Phosphorus requirements for tertiary nitrification in a biofilm**

B. NORDEHOLT (Norwegian Institute for Water Research), E. RUSTEN, B. RUSTEN, and H. ODEGAARD

*Water Science & Technology*, 1994, 29, No 10/11, 77-82

Tertiary nitrification was investigated in rotating biological contactors with different influent phosphorus concentrations. The objective was to determine the phosphorus concentration at which tertiary nitrification might be hindered by phosphorus limitation. The results suggested that tertiary nitrification in biofilm reactors was phosphate limited at influent concentrations below approximately 0.15 mg phosphate phosphorus per litre. The implication of this was that at the present practice, the extension of Scandinavian chemical treatment facilities by downstream biofilm reactors for nitrogen removal will be hindered by phosphorus limitation. **Norway**

95-1344

**Oxygen reduces denitrification in biofilm reactors**

C. HAGEDRON OLSEN (Denmark Technical University), L. ENGEL, T. H. MOJLER, H. TOTTRUP, and P. HARRÉMOES

*Water Science & Technology*, 1994, 29, No 10/11, 83-91

Nitrate removal mechanisms in a submerged fixed film filter are reviewed to show that the denitrification process was hindered significantly by the presence of oxygen. The kinetics of a fully nitrate penetrated biofilm influenced by oxygen are determined. A

linear reduction in the denitrification rate with depth of oxygen penetration proportional to the oxygen concentration to the half power is demonstrated. With a partly nitrate penetrated biofilm the influence of oxygen was a function of the ratio of the penetration of oxygen to that of nitrate without the influence of oxygen. Experimental evidence from laboratory scale studies confirmed the kinetic concepts. **Denmark**

95-1345

**Denitrification in biofilms with biologically hydrolysed sludge as carbon source**

A. AESØY (Trondheim University) and H. ODEGAARD

*Water Science & Technology*, 1994, 29, No 10/11, 93-100

The potential and limitations of the HYPRO concept, a compact process design for nutrient removal in which the carbon source for the denitrification process is supplied by hydrolysing the pre-precipitated sludge, were examined, with particular attention to the efficient utilization of hydrolysed sludge in a biofilm process. Only the volatile fatty acids in the hydrolysed sludge were utilized as a carbon source. The biofilms studied were thick (more than 400 µm) and porous, and the denitrification rate was described by a hyperbolic Monod type function with respect to both the nitrate and the volatile fatty acids concentration. The kinetic constants were determined. **Norway**

95-1346

**Carbon utilization in denitrifying biofilters**

J. LA COUR JANSSEN (Water Quality Institute, Hørsholm), S. L. JENSEN, and K. D. LAURSEN

*Water Science & Technology*, 1994, 29, No 10/11, 101-109

Carbon utilization during denitrification in submerged denitrifying biofilters was investigated. Pilot scale upflow and downflow submerged filters treating pre-settled wastewater, pre-precipitated wastewater and nitrified effluent with an external carbon source were studied. The results showed that the degradability of the influent carbon was significant in relation to the denitrification of the wastewater. Soluble easily hydrolysable organics were only partially degraded during passage through the filters, though particulate organics trapped in the filter made a contribution to the denitrification process since a portion of the particles was hydrolysed. **Denmark**

95-1347

**Biofilm reactors configuration for advanced nutrient removal**

G. RYHIMÄK (Sulzer Chemtech Ltd, Winterthur), K. SØRENSEN, B. BIRØ, and H. GROS

*Water Science & Technology*, 1994, 29, No 10/11, 111-117

A pilot scale Biopur system capable of nitrification, pre-denitrification and post-denitrification was used to characterize reactor configurations. The degradation rate limitations caused by mass transfer resistances, kinetics or stoichiometry were determined for the process stages. Experimental data suggested that in certain conditions moderate aeration of the pre-denitrification stage enhanced both denitrification and organic carbon removal due to an acceleration of diffusion rates. Factors limiting process performance were identified. The system tested offered a level of flexibility regarding BOD removal in the pre-denitrification stage through the potential for aeration and the possibility of economical nitrate recirculation. **Switzerland**

95-1348

**Operating experiences with submerged filters for nitrification and denitrification.**

B. J. MEANEY (Anglian Water Services Ltd., Cambridge) and J. E. T. STRICKLAND

*Water Science & Technology* 1994, 29, No 10/11, 119-125

A submerged biofilm reactor capable of nitrification, denitrification and solids removal was developed. The reactor utilized floating plastic granules with a density close to that of water and could be operated in aerated and non-aerated modes. The system was particularly suitable for tertiary treatment designed to achieve suspended solids levels below 10 mg per litre and ammonia concentrations below 5 mg per litre. In pre-denitrification mode, the system was capable of reducing nitrate levels in effluents from bacteria bed works to levels complying with the requirements of the EC Urban Wastewater Treatment Directive. U.K.

95-1349

**Combined nitrogen and phosphorus removal in a full-scale continuous up-flow sand filter**

B. HULTMAN (Royal Institute of Technology, Stockholm), K. JONSSON and E. PLAZA

*Water Science & Technology* 1994, 29, No 10/11, 127-134

The use of sand filters for post-denitrification was evaluated in a full-scale operation. A continuous sand filter, a DynaSand system marketed by Nordic Water Products AB, was evaluated for the combined removal of suspended solids, phosphorus and nitrogen using methanol as a carbon source for denitrification and ferric chloride for improved phosphorus removal. Effluent from a Stockholm treatment works was fed to the filter at a wide range of hydraulic loadings. The methanol dosage was controlled by continuous monitoring of nitrate in the effluent. Effluent phosphorus concentrations as low as 0.15 mg per litre were easily obtained. Denitrification rates were not affected by phosphate concentrations when the latter were above 0.1 mg per litre. Sweden

95-1350

**Biological phosphorus uptake in submerged biofilters with nitrogen removal**

R. F. GONCALVES (Anjou Recherche, Maisons Laiffite), L. Le GRAND and E. ROGALLA

*Water Science & Technology* 1994, 29, No 10/11, 135-143

Biological phosphorus removal from wastewater using a submerged biofilter was investigated at pilot scale. A floating upflow aerated filter originally designed for nitrification and denitrification was used. Factors influencing biological phosphorus removal in fixed-film processes and possible biofilter configurations favouring the elimination of carbon, nitrogen and phosphorus were examined. One or more anaerobic contact periods during the period between filter backwash procedures were employed. This made the selection of a very specific phosphorus removing bacterial population possible with any existing type of co-current or counter-current biofilter. France

95-1351

**Pre- or post-denitrification at biological filter works? A case study.**

A. DEL (WRc plc, Swindon), N. JAMES, I. JONES, J. STRICKLAND, J. UPTON and P. COOPER

*Water Science & Technology* 1994, 29, No 10/11, 145-155

The use of pre-denitrification for nitrogen removal in low-rate biological filter works was investigated at pilot scale. A range of recycle

ratios was examined to determine optimal operating conditions. Using a ratio of recycled filter effluent to settled sewage of 2:1 it was possible to meet a total nitrogen limit of 15 mg per litre. An economic comparison of pre- and post-denitrification in tertiary sand filters was also conducted. The cost effectiveness of the pre-denitrification process dependent on the price of the external carbon source used. The most cost-effective type of pre-denitrification process was biological fluidized beds. U.K.

95-1352

**A new moving bed biofilm reactor - applications and results.**

H. ODEGAARD (Trondheim University), B. RUSTEN and T. WESTRUM

*Water Science & Technology* 1994, 29, No 10/11, 157-165

The operation of a new Norwegian moving bed biofilm reactor was studied. The reactor was designed to achieve low head loss and a high specific biofilm surface by encouraging biofilm growth on small carrier elements which moved with the water in the reactor. Movement was caused by aeration in the aerobic version of the reactor and by a mechanical stirrer in the anoxic/anaerobic version. This arrangement resulted in a very compact reactor and a high biological activity per kg of attached biomass. Experience at pilot and full scale with municipal and industrial wastewater demonstrated the usefulness of the process with a broad range of wastewaters. Norway

95-1353

**Upgrading and nitrification by submerged bio-film reactors - experiences from a large scale plant**

J. H. LIESSE (Abwasserverband Ampergruppe, Eichenau)

*Water Science & Technology* 1994, 29, No 10/11, 167-174

Ways of upgrading a conventional sewage treatment works at Gieselhüllach near Munich and providing nitrification capacity were investigated. The feasibility of installing submerged biofilm reactors in the aeration tanks to increase the mixed liquor suspended solids concentration was examined. The resulting system combined advantages of contact oxidation processes and the activated sludge process. Three different types of reactor media: a rigid fixed material, small floating foam cubes, and modules containing flexible rope-like materials were evaluated. The third type of medium, known as ring lace, produced good results, including almost complete nitrification. Germany

95-1354

**The optimum medium of the suspended bio-medium aeration contactor process**

C. F. OUYANG (National Central University, Chung Li) and C. M. HIAW

*Water Science & Technology* 1994, 29, No 10/11, 183-188

The biological fluidized bed process was modified by placing granular activated carbon of various diameters in an aeration tank as a medium for the attachment and growth of microorganisms. This improved the biomass concentration, volumetric loadings and removal efficiency of the process. The continuous supply of substrates allowed the thickness of the biofilm to be adjusted. This was achieved by friction among the media elements and a shear force caused by the agitated flow. A comparison of the effects of using various particle sizes suggested that a middle-sized particle was the most suitable to achieve a high biomass concentration, stable operation and high treatment efficiency. Taiwan

95-1355

**Development of an automatic control system for monitoring an anaerobic fluidized bed.**

F. EHLINGER (Degremont, Le Pecq), Y. ESCOFFIER, J. P. COUDERC, J. P. LEYRIS, and R. MOLETTA

*Water Science & Technology*, 1994, 29, No 10/11, 289-295

An automatic control system was used to monitor the start-up procedure of a laboratory anaerobic fluidized-bed reactor. Increasing the load from 1 to 35 kg COD per m<sup>3</sup> d took 26 d. The pH of the liquid phase, gas production and the concentration of hydrogen in the gas phase were measured by on-line sensors and used to control system operation. As these parameters varied, the flow rate of the feed pump was adjusted in accordance with an algorithm based on a decision tree. Perturbations in the process generated by large variations in pH and organic overloads were used to test the control system. In overload conditions, levels of methane and carbon dioxide in the gas phase helped to identify the reactor's deviation from normal operation. **France**

95-1356

**Start-up of anaerobic fixed film reactors: technical aspects.**

H. AUSTERMANN, HAUN (Universitat Hannover), C. I. SEYFRIED, G. ZELLNER, and H. DIEKMANN

*Water Science & Technology*, 1994, 29, No 10/11, 297-306

Ways of improving the start up behaviour of anaerobic fixed film reactors were investigated at laboratory scale using 5 reactors operated in parallel. A synthetic wastewater containing acetic, propionic and butyric acids in the proportion 2:1:1 by weight with a COD of 10000 mg per litre was treated. Factors affecting start up behaviour included the activity of the starter culture, effluent recirculation, dilution dosage and the mode of increasing the organic loading rate. A start up procedure in which the substrate loading was automatically regulated according to the pH value measured in the top of the reactor was significantly more effective than manually regulated procedures. **Germany**

95-1357

**A fluidized-bed reactor: the Biolift process.**

R. BADOT (District Urbain de Nancy), T. COULOM, N. de LONGELAUX, M. BADARD, and J. SIBONY

*Water Science & Technology*, 1994, 29, No 10/11, 329-338

Biological fluidized bed reactor systems incorporating an air lift system are discussed, with particular reference to the Biolift process. The original feature of this process was that the air lift system was outside the reactor and was assisted by a system for the injection of secondary air (process air) into the reactor. This allowed tight control of fluidization and aeration factors. An industrial scale prototype at Maxeville, France, showed the feasibility of the process and allowed the physical behaviour of large fluidized beds used to treat wastewater to be investigated. This prototype was to be used to study treatment performance in real operating conditions. **France**

95-1358

**Behaviour of an anaerobic/aerobic pilot scale fluidized bed for the simultaneous removal of carbon and nitrogen.**

F. FIDELZ, POLANCO (Valladolid University), F. J. REAL, and P. A. GARCIA

*Water Science & Technology*, 1994, 29, No 10/11, 339-346

A biological fluidized bed reactor system with aerobic and anaerobic areas, capable of simultaneous removal of organic carbon and nitrogen, was developed at pilot scale. The transport of the oxidized forms of nitrogen was achieved by internal recirculation. A flow model was

developed to study the hydrodynamic behaviour of the reactor. The ratio of anaerobic to aerobic volumes was maintained approximately constant in the region of 2.5:1. Removals of COD and nitrogen, the concentration of adhered biomass, profiles of operating parameters throughout the reactor and dissolved oxygen levels in the reactor were determined. The system showed a short start up time and good operating stability. **Spain**

95-1359

**Determination of optimal biofilm activity in a biological fluidized bed (BFB) reactor**

B. RUGGERI (Universita di Torino), G. CAIRI, V. SPICCHIA, G. SASSI, F. BOSCO, and A. GIANETTI

*Water Science & Technology*, 1994, 29, No 10/11, 347-351

Biomass activity in a biological fluidized bed reactor was investigated experimentally. A semi pilot scale reactor with 2 different supports, sand and glass particles, was used. The specific biomass activity reached a maximum with respect to biomass hold up and bed expansion, before declining. Biomass activity was strongly affected by liquid solid mass transfer and support roughness, which also determined the compactness of biofilm and its diffusive properties. By controlling bed expansion it was possible to determine the macro reaction regime, external mass transfer, biokinetics and diffusive control in relation to the influent concentration to optimize reactor performance. **Italy**

95-1360

**Scale-up and biomass hold-up characteristics of biological fluidized bed reactors.**

I. OZTURK (Istanbul Technical University), M. TURAN, and A. H. IDRIS

*Water Science & Technology*, 1994, 29, No 10/11, 353-360

Basic design criteria for the scaling up or scaling down of anaerobic fluidized bed reactors were investigated. Biomass hold up characteristics of this type of reactor were studied in detail. The design of a 12.5 litre laboratory scale fluidized bed was based on that of a geometrically similar 70 litre pilot scale fluidized bed. Process performances and biomass hold up properties were compared. A general expression for the prediction of biological fluidized bed porosities was developed. Both local and overall porosities were predicted on the basis of biofilm thickness, expansion coefficient, media diameter and density. Data from the study were used to confirm the validity of the expression. **Turkey**

95-1361

**Kinetic behaviour of heterotrophic and autotrophic biofilms in wastewater treatment processes**

M. MOREAU (Institut National des Sciences Appliquées de Toulouse), Y. THU, B. CAPDEVILLE, J. M. AUDIC, and J. CALVET

*Water Science & Technology*, 1994, 29, No 10/11, 385-391

The growth dynamics of heterotrophic and autotrophic biofilms were investigated using conventional laboratory scale annular reactors. Two types of bacteria colonizing the support media at the same time, active and inactive bacteria, were distinguished. Active bacteria were found at the biofilm/liquid interface and were responsible for metabolizing substrate, while inactive bacteria were located inside the biofilm and played no role in the substrate removal process. The behaviour of autotrophic and heterotrophic biofilms was similar. It was possible to develop a thin and active nitrifying biofilm in conditions characterized by known shear forces. **France**



95-1362

**Validation of a multisubstrate mathematical model for the simulation of the denitrification process in fluidized bed biofilm reactors.**B. ERAMO (Municipal Agency for Energy and Environment, Rome), R. GAVASCI, A. MISFII, and P. VIOTTI  
*Water Science & Technology*, 1994, 29, No 10/11, 401-406

The performance of a mathematical model designed to simulate the operation of a fluidized bed biofilm reactor carrying out heterotrophic denitrification was evaluated. A series of experiments with a pilot scale reactor confirmed the ability of the simulation model to determine concentration profiles in the reactor. The model was based on multi-substrate Michaelis-Menten kinetics and took account of mass transport resistance phenomena within and outside bioparticles. Heterotrophic biological denitrification in anaerobic conditions was successfully simulated. Phenomena caused by convective transport and turbulent diffusion were taken into account. **Italy**

95-1363

**Nitrogen removal characteristics of nitrification and denitrification filters.**F. CELENI (Bogazici University, Istanbul) and I. E. GONEN  
*Water Science & Technology*, 1994, 29, No 10/11, 409-416

The feasibility of nitrogen removal from high strength wastes using submerged nitrification and denitrification filters was investigated with particular attention to the kinetic aspects of filter, arranged in series. In nitrification, 3 kinetic regions, characterized by first, half, and zero order kinetics, were distinguished. The transition from ammonia limitation to oxygen limitation occurred when the bulk oxygen/bulk ammonia ratio was about 2.5 to 4. Since this condition was often not achieved in full scale systems, the nitrification process was oxygen limited. Two kinetic regions, half- and zero order, were observed in denitrification. **Turkey**

95-1364

**Evaluation of multiple-species biofilm and flow processes using a simplified aggregate model**

H. FURUMAI (Ibaraki University, Hitachi) and B. E. RITTMANN

*Water Science & Technology*, 1994, 29, No 10/11, 439-446

The influence of microbial aggregation on the stability of nitrification in multiple-species biofilms and flows was investigated using a simplified model. The model was based on a layered system with each layer containing a different type of biomass and took account of mass transport resistance for all substrates and the formation and consumption of soluble microbial products. The model showed how the outer layer of heterotrophs in a biofilm protected the inner layers of nitrifiers and inert biomass from detachment, so ensuring greater nitrification stability. The model identified key differences among biofilm, flow and dispersed growth processes. **Japan**

95-1365

**Biofilms growing on gas permeable membranes**

C. ROTHMUND (Technische Universität München, Garching), A. CAMPER, and P. A. WIEDERER

*Water Science & Technology*, 1994, 29, No 10/11, 447-454

The use of gas permeable membranes as carriers for the growth of bacteria was examined. In the membrane biofilm reactor, the membrane separated an oxygen-containing gas space from a compartment through which wastewater was passed. This system was a promising tool for the aerobic treatment of industrial wastewaters and offered the possibility of immobilizing and exploiting bacteria with particu-

lar metabolic properties in controlled process conditions. The pores of the membranes were colonized by bacteria, though certain strains had difficulty in attaching themselves to the polyethersulfide membrane used. Scanning and transmission electron microscopy were used to study biofilm formation. **Germany**

95-1366

**Nitrogen removal from wastewaters by a bio-reactor with partially and fully submerged rotating biofilms.**

Y. WATANABE (Miyazaki University), D. Y. BANG, K. ITOH, and K. MATSUI

*Water Science & Technology*, 1994, 29, No 10/11, 431-438

The performance of a bioreactor using partially and fully submerged rotating biofilms to remove nitrogen from municipal and industrial wastewaters was studied. The system achieved simultaneous nitrification and denitrification in the partially and fully submerged biofilms, respectively. The effect of the ratio of the concentrations of influent organic carbon and ammonia nitrogen on the efficiency of the process was determined. Settled municipal wastewater and a synthetic wastewater containing ammonia nitrogen and organic material such as acetate, ethylene glycol, phenol and polyvinyl alcohol were successfully treated. **Japan**

95-1367

**Advanced wastewater treatment plants in lagoons combined with biological contactors**

P. SCHUEYER (Bayer-Landesamt für Wasserwirtschaft, München)

*Water Science & Technology*, 1994, 29, No 12, 13-21

A full scale lagoon system of wastewater treatment was operated by rotating biological contactors (RBC) designed for nitrification. The system consisted of an anaerobic lagoon, 2 RBC, a high loaded sedimentation tank from which sludge was recycled at 150-250 per cent of dry weather flow to the lagoon, a sedimentation and polishing pond, and finally treatment by marsh plants. The total nitrogen loading on the RBC was  $0.7-0.8 \text{ g per m}^2 \text{ d}$  while BOD loading of  $1.1-2.0 \text{ g per m}^2 \text{ d}$  was greatest in winter. Removal efficiency and process stability were consistently high while enhanced biological phosphorus removal was also achieved. **Germany**

95-1368

**Upgrading of rotating biological contactor (RBC) systems to achieve higher effluent quality, including biological nutrient enrichment and reduction techniques.**

K. E. NEL (Environmental/Health Services, Richtfield, Wis.)

*Water Science & Technology*, 1994, 29, No 12, 197-206

Methods of improving the performance of rotating biological contactor (RBC) are discussed. Up-rated bearings, the use of load cells to monitor biomass, supplemental aeration and air assisted rotation are considered. Process upgrades are based on solids recirculation which improved nitrification, allowed denitrification in a modular system with methanol addition, and enabled some phosphorus removal. Solids recirculation from the secondary sedimentation tank was applied to a unit of 4 bioreactors in series to improve margin of performance. The RBC lost 25-50 per cent of their biomass but this was offset by the increased suspended solids. Effluent quality improved 50 per cent and a significant reduction of nutrients occurred. Surplus sludge settled and dewatered much more readily than from conventional RBC. Recirculation appeared to reduce disc surface area needs by 25 and 30 per cent for carbon and nitrogen removal, respectively. **U.S.A.**

95-1369

**A thickening model for activated sludge secondary settlers.**

A. L. RUTIKOETXEA (CEIT, San Sebastian) and J. L. GARCIA HERAS

*Environmental Technology*, 1994, 15, No 11, 1051-1060

A dynamic thickening model for a laboratory scale secondary settling tank used the sludge blanket concentration profile to obtain mass stored in the settling tank and included the relationship between thickening zone height in the blanket and bottom concentration. The proposed model was coupled to a biodegradation model to yield a global model of the activated sludge process and predicted variables included biodegradation, sludge blanket height, recycle concentration and stored mass. Continuous thickening tests were conducted for model calibration, and computer simulations demonstrated the influence of incoming flow and underflow rates on predicted variables and illustrated model performance under hydraulic and biodegradation transient states. **Spain**

95-1370

**Implications of activated sludge kinetics based on total or soluble BOD, COD and TOC**

A. M. EL REHAILI (King Saud University, Riyadh)

*Environmental Technology*, 1994, 15, No 12, 1161-1172

A steady state kinetic model of the activated sludge process is presented and different combinations of total and/or soluble BOD, COD or total organic carbon (TOC) obtained for a municipal wastewater treated in experimental reactors were employed to determine the 4 kinetic coefficients used in the model equations. In determining the 2 micro-organism growth kinetic coefficient, the model results were in good agreement with experimental values for all data combinations. Only BOD data could be used to determine the 2 substrate removal coefficients unless the non-biodegradable fractions of effluent soluble COD and TOC (16.0 mg per litre and 3.3 mg per litre respectively) were removed. Application of BOD kinetic coefficients determined from total feed and soluble effluent BOD data illustrated the potential errors resulting from the use of published kinetic coefficients without knowing the basis for their determination. **Saudi Arabia**

95-1371

**Vitamin additions in the course of biological sewage treatment: part II: needs of saprophytic bacteria of various taxonomic groups in industrial and municipal sewage treatment plants for the vitamins of the B group**

C. LIND (Landesanstalt für Wasserversorgung, München) and H. LEMMER

*Wasser-Abwasser*, 1994, 135, No 11, 642-645 (in German, English summary)

The vitamin B requirements of saprophytic bacteria present in activated sludge biocoenoses obtained from municipal and industrial effluent treatment plants were investigated as part of a study of the possible benefits of vitamin supplementation for the activity of the biomass. With the exception of Cytophagaceae and certain Flavobacteria organisms requiring vitamins of the B group were derived from all the relevant classes, including *Clostridia*, *Bacilli* and proteobacteria groupings; their requirements were however limited to biotin, thiamine and nicotinic acid. It remains to be shown whether any special metabolic functions can be positively influenced by the addition of these vitamins when the organisms form part of a specialized biocoenosis for specific treatment objectives. **English translation** 160 pounds sterling valid for 1995. **Germany**

95-1372

**Comparison of single-stage and two-stage activated sludge processes for the expansion of the Innsbruck WWTP.**

H. K. WINKLER (ILF Consulting Engineers, Innsbruck) and W. WIDMANN

*Water Science & Technology*, 1994, 29, No 12, 69-79

Single stage and AB processes were compared as options for the expansion of a sewage works in parallel pilot plants. The single stage process consisted of a primary clarifier followed by anoxic and oxic activated sludge stages with anaerobic tanks off line. The AB process incorporated an initial aeration tank and an intermediate sedimentation tank followed by the same processes as the single stage unit. Direct feed to the anoxic stage was also possible. Both processes could meet effluent discharge requirements of BOD, ammoniacal nitrogen and total phosphorus of 15, 5 and 1 mg per litre respectively. Aeration tank volumes for the single stage process were 25 per cent higher than for the AB process but the single stage process was preferred because it was more space efficient overall, simpler to operate and the old plant could be more easily upgraded on this basis. **Austria**

95-1373

**Upgrading of the wastewater treatment plant of the city of Oldenburg**

R. KAYSER (Technische Universität Braunschweig)

*Water Science & Technology*, 1994, 29, No 12, 89-95

The Oldenburg sewage treatment plant was extended to meet BOD, total inorganic nitrogen and total phosphorus concentrations of 20, 18 and 1 mg per litre respectively. A single stage activated sludge plant with enhanced biological phosphorus removal, phosphorus precipitation and pre-anoxic zone denitrification was chosen. The reactor volume was calculated for a sludge age of 12 d. The anoxic fraction could be varied between 0.3 and 0.5 for flexible operation. Initial problems of air distribution were overcome by reducing the head above 2 of the diffuser systems. Conventional circular clarifiers with scrapers but without sludge hoppers were used to simplify the construction of the tanks in ground with a high water table. Initial results indicated that the plant would achieve its standard. **Germany**

95-1374

**Upgrading of existing sewage treatment plants by computer simulation: game or reality?**

R. J. van der KUIJ (DHV Water BV, Amerstoft), A. G. N. van BENTHEM and E. J. van BREEKLEEN

*Water Science & Technology*, 1994, 29, No 12, 97-106

An advanced sewage treatment model, STRIAM, was applied to improving the performance of the Kralingseveer sewage works so that it achieved 75 per cent removal of influent nitrogen and phosphorus. The effect of different control mechanisms and other measures could be studied without costly research. The model was calibrated with data from the original plant, a low loaded Carroussel activated sludge with pre-sedimentation. Improvements were obtained by integrated aeration control and on line measurement of ammonia and nitrate concentrations together with maintenance of a high mixed liquor solids concentration and the denitrification of return sludge. Pre-denitrification, optimization of the influent feed and total precipitation did not seem worthwhile for nitrogen removal. The model's results would be tested in a pilot plant. **Netherlands**

95-1375

**Upgrading of waste-water treatment plants for the biological nitrogen elimination by the injection of on-line prepared mixed cultures.**

M. GLANCER (Zagreb University, Croatia), S. BAN, V. SOJICAN and I. PASCIC

*Water Science & Technology*, 1994, 29, No 12, 129-138

The propagation of mixed cultures of bacteria and fungi of known kinetic and growth characteristics, and their semi-continuous injection into activated sludge were studied in 2 types of application. Nitrification was achieved in both cases. The performance of a plant removing COD and phenol from coke oven waste was uprated to oxidize ammonia by a designed mixed culture. In another example, at the Salzburg municipal activated sludge plant, a mixed culture of nitrifying and oxygen tolerant denitrifying strains achieved a total nitrogen removal of 70-75 per cent. Enrichment of normal activated sludge with such cultures could obviate the need to extend over-loaded wastewater treatment plants. **Europe**

95-1376

**Upgrading of activated sludge systems for nitrogen removal by application of the LINPOR CN process**

M. R. MORFER (LINDE Aktiengesellschaft, Munich)

*Water Science & Technology*, 1994, 29, No 12, 167-176

The LINPOR CN process was a means of upgrading activated sludge plants for carbon and nitrogen removal by introducing highly porous plastic foam cubes to the extent of the 10-30 per cent of the liquid volume. Effluent screens prevented the cubes leaving the aeration zone. Twenty-three plants were in operation or under construction, principally in Germany. The growth of fixed biomass increased volumetric efficiency compared with conventional plants. Simultaneous nitrification and denitrification took place. Details of the Freising sewage treatment plant are provided. **Germany**

95-1377

**Upgrading of a two-stage treatment plant for nitrogen elimination.**

O. BURICA (Domžale Kommun Wastewater Treatment Plant), R. VODOPIVIC and M. STRAZAR

*Water Science & Technology*, 1994, 29, No 12, 283-289

Enhancements to a 2-stage activated sludge plant were proposed which would extend the second stage for nitrification and denitrification. The sludge age would be 12 d. The second stage would be formed from conversions of the former secondary sedimentation tanks. These were to be increased by 30 per cent and new final sedimentation tanks constructed. The first stage would remain as a highly loaded activated sludge unit. The design would use as much of the existing units as possible, being constrained by the nature of the site. The proposals were to be tested in a pilot plant. **Slovenia**

95-1378

**Consequences of the behaviour of activated sludge plants with combined sewage inflows.**

J. LONBONG (Wuppertalverband, Wuppertal)

*Water Science & Technology*, 1994, 30, No 1, 139-146

Dynamic simulation was used to investigate the influence of combined sewage inflows on activated sludge plants. The IAWQ Activated Sludge Model No 1 was used to model the Buchenhofen treatment plant. Following an increase in the water inflow rate due to rain, there was a significant increase in the nitrogen concentration of the outflow of the activated sludge tank. This was due to the total Kjeldahl nitrogen influent load peak generated by the combined

sewer inflow, together with displacement of biomass to the secondary sedimentation tank. The ammonium effluent concentration increased with the ratio of dry weather flow to combined sewerage flow. Measures were required to buffer these load peaks in the inflow zone. Best results were achieved with inflow storage. **Germany**

95-1379

**Simulation of the operating conditions of the municipal wastewater treatment plant at low temperatures using a model that includes the IAWPRC activated sludge model.**

N. FUNAMIZU (Hokkaido University, Sapporo), and T. TAKAKUWA

*Water Science & Technology*, 1994, 30, No 4, 105-113

The effects of low sewage temperatures, which would arise from discharging snow to the sewers, on treatment processes were modelled with the aid of data from a pilot activated sludge plant operating at 10°C. Primary clarification was expressed by a Voshel and Sak type formula, and secondary clarification by an empirical model refined by Chapman. Aeration tank performance was described by the IAWPRC model. Thickening and sludge pressing were also simulated. The IAWPRC model was calibrated from the pilot plant results and verified from data obtained at other temperatures. Simulation of sludge and cake production, mixed liquor solids and nitrifying bacteria at these temperatures would overload the existing sludge treatment process. **Japan**

95-1380

**Optimisation of wastewater treatment plants by means of computer models.**

R. DUPONT (Kruger Systems AS, Soborg), and O. SINKJAER

*Water Science & Technology*, 1994, 30, No 4, 181-190

The optimization of wastewater treatment was studied in a pilot plant employing anaerobic, anoxic and aerobic processes. A computer model, EFOR Version 2.20 based on the IAWPRC activated sludge model No 1, was selected. The primary tool of calibration was the characterization of the wastewater and activated sludge. Special attention was given to nitrification, known from previous investigations to suffer occasional inhibition. Model constants for nitrification were determined from experiments. Default constants were used for most of the others. The calibrated model was applied to the operation of the pilot plant, giving dissolved oxygen set points, sludge age and the length of the operating cycle. These improved operation, although the aerobic sludge age of 17.3 proved 2 d too low for stable nitrification. The project demonstrated the feasibility of optimizing a treatment plant by computer modelling. **Denmark**

95-1381

**Parameters for dynamic simulation of wastewater treatment plants with high-rate and low-rate activated sludge tanks.**

E. BRANDS (RWTH Aachen), M. HILFESKIND and M. DOHMANN

*Water Science & Technology*, 1994, 30, No 4, 211-214

Parameters for activated sludge plants comprising a high followed by a low rate process were measured by several techniques. The yield coefficient was obtained respirometrically after adding a known amount of COD to a sludge in the endogenous stage. Biomass was measured by DNA analysis and decay rate by monitoring the decrease of DNA. Maximal specific growth rate was calculated from respirometric data by applying Michaelis-Menten kinetics. High rate sludges had lower biomasses and yield coefficients than low rate sludges, decay rates and maximal specific growth rates did not differ

greatly. All the determined kinetic parameters were below reported values. Germany

#### 95-1382

**(On-line estimation of the respiration rate and the oxygen transfer rate at Kungälv wastewater treatment plant in Uppsala.**

B. CARLSSON (Uppsala University), C. F. LINDBERG, S. HASSELBLAD, and S. XU

*Water Science & Technology*, 1994, 30, No.4, 255-263

An algorithm was developed to estimate the oxygen transfer and respiration rates in activated sludge. It used a Kalman filter approach where the oxygen transfer rate was modelled with a static, constrained, piecewise linear model, while respiration rate was represented as a random walk. The Kalman filter recursively estimated the model parameters to track time variations in the respiration rate. The procedure was tested on a full-scale plant. Batch laboratory tests were carried out to obtain the respiration rate whose values showed good agreement with calculated results. The control of dissolved oxygen concentration at this plant is described. Sweden

#### 95-1383

**Monitoring of the maximum respiration rate.**

H. SPANJERS (Wageningen Agricultural University), H. TEMMINK, and A. KLAPWIJK

*Water Science & Technology*, 1994, 30, No.4, 285-288

A continuous respiration meter with sludge flowing through the respiration chamber was fed with wastewater exceeding a critical flow to obtain the maximal respiration rate. This was verified at intervals by stepwise increases of the wastewater flow. The maximal respiration rate of activated sludge was measured in a pilot plant subjected to influent flow of a square wave pattern with a 12 h period. Mean respiration rate rose when the flow was high and fell at low flows. Netherlands

#### 95-1384

**Three years of full-scale Captor process operation at Moundville WWTP.**

P. S. GOLLA (PWT Waste Solutions, Inc., Houston, Tex.), M. P. REDDY, M. K. SIMMS, and T. J. LAKEN

*Water Science & Technology*, 1994, 29, No.10/11, 175-181

The Captor process was evaluated at full scale during a three year period at the Moundville/Glen Dale wastewater treatment works in West Virginia. The process utilized reticulated biological support media to retain large amounts of active biomass in the reactor. The reactor was filled with reticulated polyurethane foam media having about 97 per cent void space, so allowing a combination of attached and suspended growth processes. The Captor unit took up about a third of the total hydraulic retention time of the activated sludge process. A 95 per cent soluble CBOD<sub>5</sub> removal, 70-90 per cent nitrification and 40-60 per cent denitrification were achieved in the Captor unit. U.S.A.

#### 95-1385

**A novel high rate method for the nitrification of sludge liquors containing high levels of ammonia.**

S. R. PICKIN (Engineered Biological Services, Slough), and F. J. SAUNDERS

*Water Science & Technology*, 1994, 29, No.12, 139-147

The nitrification of solutions containing 500-1000 mg ammoniacal nitrogen per litre as ammonium chloride was demonstrated in a 17-litre laboratory reactor containing foam blocks seeded with *Nitrosomonas* and *Nitrobacter* cultures. The treatment of digested

sludge liquors was then evaluated at 30°C in a pilot activated sludge plant containing foam blocks with pH maintained at 7.2-7.6. The plant was also initially seeded with nitrifying bacteria. An effluent standard of 40 mg ammoniacal nitrogen per litre was achieved at nitrogen loading rates of 1-2 kg per m<sup>3</sup> d, although supplemental oxygen was necessary above 1 kg nitrogen per m<sup>3</sup> d. The foam blocks efficiently supported the nitrifying population and the free sludge settled quickly. There was evidence that the plant would have operated adequately without foam blocks. Nitrogen loss across the reactor was 6.5-17 per cent, through volatilization, cell growth and denitrification. U.K.

#### 95-1386

**Upgrading to nitrogen removal with the KNT moving bed biofilm process.**

B. RUSTEN (Aquateam - Norwegian Water Technology Centre, Oslo), J. G. SILJDALEN, and B. NORDEIDE

*Water Science & Technology*, 1994, 29, No.12, 185-195

An activated sludge plant preceded by chemically-assisted sedimentation was upgraded for nitrogen removal by converting the aeration basin to a moving bed biofilm reactor. Biofilm carrier elements were 10 mm polyethylene cylinders of 0.92-0.96 g per cm<sup>3</sup>. Aeration or stirring continually moved the elements upwards over the surface of the sieve that prevented their leaving the reactor. No recycling of displaced biomass was necessary. The aeration basin was split into 5 aerobic zones, 2 for denitrification with methanol addition and the last for post aeration. Average biomass concentration was around 4 kg per m<sup>3</sup> and specific sludge production 0.36 kg per kg COD removed. Significant nitrification began at 1.5-2.2 kg BOD per m<sup>3</sup> d. Nitrification rates up to 750 g oxidized nitrogen per m<sup>3</sup> d were observed. Nitrogen removal of 80-90 per cent could be obtained with a total empty bed hydraulic retention time of 2.6 h. Norway

#### 95-1387

**Characterisation of the nitrification process for design purposes.**

O. SINKJAER (E. Kruger Systems AS, Soborg), L. NYDGAARD, P. HARREMOES, and J. L. HANSEN

*Water Science & Technology*, 1994, 30, No.4, 47-56

Design data for upgrading Copenhagen's sewage works to nutrient removal status were obtained from 4 years' pilot plant experiments. The selected configuration was an anaerobic reactor followed by alternating anoxic and aerobic activated sludge reactors. The plant was operated so that the kinetic parameters obtained could be compared with literature values. Maximal nitrification rates were obtained by frequent sampling of mixed liquor from the pilot plant over 3-24 h. Less accurate versions of the latter test were carried out more frequently on site to minimize costs. The test results were interpreted according to Michaelis-Menten kinetics and corrections for temperature by a modified van't Hoff-Arrhenius equation. Raw data were normalized to facilitate comparisons with literature values. Corrections for substrate limitation and the fraction of nitrifying bacteria in the activated sludge were also necessary. The results yielded design data and also indicated the occasional presence of inhibitors. Denmark

95-1388

**Real-time control of nitrogen removal at full-scale using oxidation reduction potential**

K. WOUTERS, WASIAK, C. LEMIGRÉE (Centre national du Mécanisme Agricole de Génie Rural des Eaux et des Forêts, Paris), A. HEDUET, J. M. AUDIC, and F. LELIVRE,  
*Water Science & Technology*, 1994, **30**, No 4, 207-210.

Nitrogen removal was optimized at a full scale biological nutrient removal activated sludge plant with anaerobic, anoxic and aerobic stages by on line monitoring of oxidation reduction potential (ORP) and dissolved oxygen (DO). The set points for ORP were 250 and 20 mV relative to a silver/silver chloride electrode: the lower value reactivating the air supply. Breakpoints were recorded in DO and ORP time profiles when the ammoniacal nitrogen concentration was below 1 mg per litre for a few minutes. Breakpoints on the ORP time profile after cessation of aeration occurred if oxidized nitrogen was below 1 mg per litre and the DO at the end of the aerobic cycle did not exceed 5 mg per litre. The breakpoints were not seen under conditions of over- or under aeration. **France**

95-1389

**New BPR process achieves high phosphorus removal levels.**

J. C. LAMB (Piedmont Olsen Hensley, Raleigh, N.C.) and M. A. BROOKHART,  
*Public Works*, 1994, **125**, No 11, 38-39.

The POH process from Piedmont Olsen Hensley is a recently patented biological phosphorus removal (BPR) process that had achieved higher removal rates from wastewater than previous processes. The POH process used 2 sidestreams to achieve removal and to provide flexibility and increased operation control. Following experimental and field studies a full scale process had been installed in 1992 at the Wilson, N.C. treatment facility. Advantages of BPR included flexibility, steady state sidestream processes, independent control and optimization, lower chemical costs, lower energy requirements and reduced sludge production. Design and process optimization is described and initial operational results are summarized. **U.S.A.**

95-1390

**Study of the phosphate removal process: Impact of trisodium salt of nitrilotriacetic acid (NTA)**

K. EL FAIAKI (Ecole Nationale Supérieure de Chimie de Rennes), A. PEISADOUX, and G. MARTIN,  
*Tribune de l'Eau*, 1994, **47**, No 571, 21-27 (in French-English summary).

The influence of different concentrations of nitrilotriacetic acid (NTA) on the biological phosphorus removal efficiency of activated sludge biomass was investigated in the laboratory. A discontinuous method involving alternative exposure of the biomass to aerobic and anaerobic conditions indicated that inhibition of phosphorus uptake occurred at a level of 40 mg NTA per g biomass (dry weight). In a bench scale continuous system however, there was a fall in the nitrogen and phosphorus removal performances 10 d after the introduction of NTA at a concentration less than the inhibitory value. Following this the precipitation of phosphate by aluminium or ferric salts added to samples of settled sewage containing added NTA was examined using a jar test procedure. The results indicated no adverse effects due to NTA on the coagulation process, with no differences in the removal efficiency when either of the trivalent metals or calcium were used as coagulants. There are 32 references. (English translation 265 pounds sterling, valid for 1995). **France**

95-1391

**Plant removes phosphorus to protect scenic river.**

C. EDWARDS (Tahlequah Public Works Authority, Okla.), and M. ARAND,

*Water Engineering & Management*, 1994, **141**, No 10, 22-23.

The design and operation of the new 9 million U.S. dollar wastewater treatment works in Tahlequah, Okla. is described. The facility was designed to meet restrictive state standards and operated under stringent discharge permits for BOD, total suspended solids, ammonia nitrogen and phosphorus into the Illinois river, protected under the Scenic River Act. Sequencing batch reactors were installed into the process scheme to provide a conventional secondary treatment system which also reduced phosphorus levels. The system operated as a fill and draw activated sludge process with biological removal of phosphorus. The resulting phosphorus and nitrogen-laden liquids/solids mixture obtained from the works was marketed as low grade agricultural fertilizer. **U.S.A.**

95-1392

**Evaluation of phosphorus removal in the activated sludge process.**

S. J. DUFFY (Queen's University, Kingston, Ont.), J. E. DEUTSCHMAN, and G. W. van LOON,

*Water Pollution Research Journal of Canada*, 1994, **29**, No 4, 487-506.

The behaviour of aluminium and phosphorus was examined during different stages of an activated sludge wastewater treatment plant at Kingston, Ont. Alum was used as a coagulant. Laboratory experiments were conducted to investigate the types of chemical reactions taking place. Throughout the system most of the aluminium was present as particulate material. Most of the phosphorus leaving the treatment plant was in the form of unsettled particulates associated with residual aluminium. Modification of an existing activated wastewater treatment plant to optimize mixing of coagulant with aeration tank effluent would improve phosphorus removal. Laboratory experiments showed that concentric mixing for 3-5 minutes at the location of alum addition, followed by smooth transfer of the coagulating/flocculating solids, led to efficient settling. If mixing conditions were too vigorous, too mild, too short or too long, phosphorus removal would not take place. The presence of dissolved organic carbon (DOC) in wastewater could inhibit aluminium precipitation and therefore alum should be added at a point where DOC is minimal. **Canada**

95-1393

**A mathematical model for enhanced biological phosphorus removal.**

A. ANTE (RWTH Aachen), H. U. BLSCHÉ, and H. VOSS,

*Water Science & Technology*, 1994, **30**, No 2, 193-203.

The simultaneous removal of nitrogen and phosphorus in an activated sludge plant was simulated in a model based on the IAWPRC model No 1. Assumptions were made for the microbial conversion steps, physical transfer and storage processes under aerobic and oxygen free conditions. The fate of 16 water quality and biomass components was depicted by 12 stoichiometric and 26 kinetic parameters with 6 correction factors. A matrix of mass balance equations of organic processes and transport was created. The differential equations were solved using a modified first Euler method. Good agreement between experimental and simulated data were obtained for a laboratory experimental plant. **Germany**

95-1394

**Modelling oxidation ditches using the IAWPRC activated sludge model with hydrodynamic effects.**A. I. STAMOU (Athens National Technical University)  
*Water Science & Technology*, 1994, 30, No 2, 185-192

The concentration of active heterotrophic biomass, the readily degradable substrate and dissolved oxygen (DO) in a completely aerobic ditch were predicted by a mathematical model. The 1-dimensional convection-dispersion equation for biomass, COD and DO concentration were used and hydrodynamic effects represented by the values of the average flow velocity and dispersion coefficient. Biological processes were described according to the IAWPRC activated sludge model using typical model parameters at 10°C. Equations were solved with the finite volume method. Among the model's conclusions were: steady state biomass concentrations were almost constant throughout the ditch; steady state COD concentrations were very low; COD removal efficiency was almost independent of flow velocity and dispersion coefficient. The distribution of DO was very sensitive to flow velocity, dispersion coefficient and the capacity of the reactors. Daily sludge production, oxygen requirements and sludge age were also calculated. **Greece**

95-1395

**Influence of a horizontal flow on the performance of fine bubble diffused air systems**D. A. SILVA, D. FERONZIER (Centre National de Machinisme Agricole du Genie Rural, des Eaux et des Forests, CEMAGREF, France), P. DUCHENE and C. RAMET  
*Water Science & Technology*, 1994, 30, No 4, 89-96

Experiments in a 1400 m<sup>3</sup> annular ditch fitted with 2 mixers and fine bubble diffusers demonstrated and quantified the improved oxygen transfer resulting from the horizontal rotation of the water. Compared to pure horizontal flow, oxygen mass transfer in clear water increased 40-50 percent for a horizontal flow of 0.4-0.5 m per second. DO was relatively independent of diffuser air flow; there was no limitation exceeding this horizontal flow. The improvement arose from a prolongation of air bubble contact time, air bubble deformation (especially from the decrease in the diameter of the nascent bubbles), shearing (elimination of air bubble coalescence) and the renewal of the liquid layer around the air bubbles were all insignificant factors. **France**

95-1396

**Improvement of sludge sedimentation by installation of upward flow clarifiers**J. THORNDALH (Watergroup A/S, Birkerød)  
*Water Science & Technology*, 1994, 29, No 12, 227-236

The installation of an upward flow clarifier in a radial secondary sedimentation tank operating at or beyond its design capacity is described. The clarifier was a modular construction of a twin polyester membrane with an aperture of 1800 µm stretched over a rigid 5 mm square section aluminium framework. Different mesh apertures could be used. It overcame the problems of sludge sedimentation at the outer wall of the tank and acceleration of the water velocity at the weir. In storm conditions it prevented wash out of activated sludge, thus eliminating the pollutional load to the watercourse and the temporary loss of treatment capability. Filamentous activated sludge was also retained. This approach was considerably cheaper than sand filters or additional sedimentation tanks. **Denmark**

95-1397

**On-line flux-theory based control of secondary clarifiers**P. BALSLEV (Water Quality Institute Aarhus), C. NICKELSEN and A. LYNGGAARD JENSEN  
*Water Science & Technology*, 1994, 30, No 2, 209-218

Dynamic on-line control of secondary clarifiers under all flow conditions was achieved by the application of flux theory combined with measurements of sludge level, suspended solids and flow at critical points. Using changes in sludge volume index, sludge concentration inlet and outlet flows it was possible to calculate whether a clarifier was overloaded with respect to settling or thickening. The information, including sludge settling velocities, was provided by several sensors. The developed dry weather strategy sought a reduction in return sludge pumping and consequent energy savings. The high flow strategy would reduce storm overflows in the plant and sewers and treat the maximal flow compatible with good effluent quality. **Denmark**

95-1398

**Numerical modelling and measurement in a test secondary settling tank**C. DAHL (H. Kruger Systems AS, Søborg), J. LARSEN and O. PETERSEN  
*Water Science & Technology*, 1994, 30, No 2, 219-228

A flow model solving the flow field equations including turbulence and a suspended solids model based on the transport/dispersion equation were combined to give a numerical model describing the complex interrelated hydraulic and sedimentation phenomena in the transport and sedimentation of activated sludge. It included free and hindered settling and the Bingham plastic characteristic. Settling and test tank experiments measured calibration parameters for the model's description of settling and density differences. Different inlet geometry, hydraulic and sludge loads were employed. After calibration, the model predicted test tank results reasonably accurately. The model and test tank showed flow field patterns identical to those in full scale tanks. Further improvements could come from a specific calibration of the Bingham plastic characteristic and better knowledge of activated sludge suspension rheology. **Denmark**

95-1399

**Influence of combined sewage influent on secondary clarifiers of activated sludge plants**A. DEJENING (Munich Technical University, Garching)  
*Water Science & Technology*, 1994, 30, No 4, 67-70

The influence of natural and simulated storm events on a secondary clarifier were investigated at a sewage works of 15 000 population equivalent. Storm flows raised the sludge blanket but effluent quality did not deteriorate until the sludge was 0.5 m below the surface. Steady flows around twice dry weather flow had little effect on effluents. Deterioration was greatest when flows increased rapidly, indicating that clarifier design should have regard to inflow dynamics in addition to numerical values of the hydraulic loading. **Germany**

95-1400

**Biological treatment of municipal wastewater in Berlin, using a 10 m deep basin and flotation for secondary clarification**H. BENNOI (Hoechst AG, Frankfurt), A. PETERFROHICH, V. SCHMIDT and C. SCHUSTER  
*Water Science & Technology*, 1994, 30, No 4, 81-88

Following difficulties with the sedimentation of activated sludge from 10 m deep aeration tanks, separation by flotation was investi-

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gated in a pilot plant with a 15 m deep aeration tank. Although effective, the investigation was switched to a 10 m tank because the deeper tank was considered uneconomic. This also proved satisfactory. Despite a pH of 6.6 in the aeration tank, about 0.4 units lower than for shallow tanks, COD, nitrogen and phosphorus removal were not adversely affected. Energy requirements were about 10 per cent lower than for a conventional arrangement, partly because floated sludge was concentrated to 30–45 g per litre, thus making further thickening unnecessary and reducing the flow of return activated sludge. **Germany**

95-1401

**The use of algae for post-treatment of sewage and of seasonal source water.**

W. M. WILGANT (HASKONING BV), J. W. MUIJDER, and B. van der VIER

*H2O* 1994, 27, No 25, 728–735 (in Dutch, English summary, p. 727)

A techno-economic study is offered of the potential of algal ponds for the removal of nutrients from sewage and other waters in temperate climates. The mathematics of the accumulation of nitrogen and phosphorus in algal cells, and the growth of biomass anticipated under given conditions of light and temperature when nutrients are not growth limiting, are expounded. Although the removal of the biomass from the ponds would remove the nutrients uptaken, the costs of construction and operation of ponds of sufficient size, especially where land values were high, compared unfavourably with those of alternative biological methods. (English translation 300 pounds sterling, valid for 1995). **Netherlands**

95-1402

**Possibilities and limits of stabilization ponds in wastewater treatment.**

J. BONToux (Faculté de Pharmacie, Montpellier) and B. PICOT

*Water Pollution Research Journal of Canada* 1994, 29, No 4, 545–556 (in French, English summary)

Techniques for treating wastewater through stabilization ponds need to be adapted to specific climate conditions. The effectiveness of purification systems is largely dependent on their management, which must focus on seasonal and, sometimes, diurnal cycles. Limits are directly dependent on low winter light conditions. Experiments with high rate algal ponds are reported. These showed the operational complexity of even a simple pond system and demonstrated the potential improvements in performance offered by sequential releases of treated water from the ponds. (English translation 110 pounds sterling, valid for 1995). **France**

95-1403

**Optimal conditions for using magnetite in water treatment processes.**

A. P. SHUTKO (Polystekhn. Institute, Kiev), V. M. RADOVENCHIK, and N. D. GOMEL'YA

*Journal of Water Chemistry and Technology* 1994, 16, No 1, 24–26

Dissolution of magnetite, prepared from a mixture of iron(II) and iron(III) in the presence of ammonium hydroxide, in aqueous solutions of different composition is reported. Optimal conditions for treatment of wastewaters are presented. Solubility of magnetite decreased with aging time of the precipitate at pH between 1 and 4. Initial concentrations of iron had little effect on magnetite solubility.

Optimal conditions for treatment of wastewaters with magnetite were derived. **Ukraine**

95-1404

**Upgrading a low-cost physicochemical wastewater treatment plant to solve operational problems.**

H. D. TAYLOR (Brighton University, UK), M. P. GAMBRILL, D. D. MARA, and S. A. SILVA

*Water Science & Technology* 1994, 29, No 12, 247–254

Crude macerated sewage was treated with lime in a pilot plant to produce effluent suitable for irrigation, having first demonstrated feasibility in jar tests. The standards were 1000 faecal coliforms per 100 ml and one intestinal nematode egg per litre. The pH was raised to 11.1–1.5 by the addition of lime slurry in a flash mixer with coagulation and flocculation times kept short, followed by 12 h sedimentation in a horizontal flow tank with a sludge hopper at the inlet. The effluent passed through a recarbonation basin with a retention time of 48 h. Frequent cleaning of pipework was required in the initial plant to avoid clogging with lime slurry; this was minimized in subsequent equipment by a change in geometry. Sedimentation tank design was improved to overcome short circuiting and aid sludge removal. Gel-filled, low sodium error pH electrodes were employed, being more robust in the aggressive, high lime environment. **Brazil**

95-1405

**Coagulation and flocculation of stormwater from a separate sewer system - a new possibility for enhanced treatment.**

B. HEINZMANN (Berliner Wasser Betriebe)

*Water Science & Technology* 1994, 29, No 12, 267–278

The treatment of water from a separate stormwater sewer was investigated in a pilot plant. Coagulation and flocculation with 0.08 mmol polyaluminium chloride per litre and cationic flocculation at pH values above 6 destabilized colloids in addition to rendering solids filterable. A constant dosage was adequate because pH and acid combining capacity were relatively unchanged as flows altered. The best process was coagulation and flocculation in a pipe, sedimentation, separation by filtration, and percolation into the ground. This treatment removed lead and copper pollutants in addition to solids. Storage within the drainage system before treatment reduced cost. Enhanced treatment was 10–40 per cent more costly than simple sedimentation. **Germany**

95-1406

**The Actiflo process - a highly compact and efficient process to prevent water pollution by stormwater flows.**

E. GUILLIN (O.I.V. Omnium de Traitement et de Valorisation), Courbevoie), F. DELSALLE, and P. BINOT

*Water Science & Technology* 1994, 30, No 1, 87–96

The Actiflo process combines the advantages of lamellar settling and weighted flocculation using microsands. The process was evaluated for its ability to deal with peak flow stormwater in a pilot plant treating wastewater from the Colombes plant, Paris, France. The following parameters were tested: residence time in the flocculation tanks, upflow velocity, dosage of polyelectrolyte and ferric chloride, microsand rate, and recycling flow rate. With an upflow velocity of up to 135 m per h, total residence time in coagulation and flocculation stages of less than 10 minutes, concentrations of ferric chloride, coagulant and polymer of 50–100 and 0.5–1 g per m<sup>3</sup>, respectively, recycled microsand rate of 3 kg per m<sup>3</sup> and power consumption of less than 30 W per m<sup>3</sup>, removals of more than 80 per cent total suspended solids, 57 per cent total COD, 55 per cent total BOD<sub>5</sub>.

more than 80 per cent total phosphorus and 15-20 per cent total kjeldahl nitrogen were obtained. **France**

95-1407

**Development of a land limited wastewater treatment plant for small and rural communities in the tropics.**

P. Y. YANG (Hawaii University, Manoa, Honolulu), H. CHEN and T. MA

*Water Science & Technology* 1994, 29, No 12, 1-12

Sewage was treated in pilot single ponds filled with volcanic rock in horizontal or vertical mode, and in a laboratory upflow aerated fixed microbial bed using cellulose triacetate as carrier. The last system was applicable where land was strictly limited. The pilot units applicable to moderate land restrictions effected purification with biofilm attached to the rock and aquatic weed on the surface. A domestic sewage loading of 135 kg BOD per ha/d was removed by 85 per cent in the vertical system. Synthetic wastewater BOD in the horizontal unit was reduced by 92 per cent. In the strictly land limited approach 90 and 85 per cent of total and soluble COD respectively were removed at the loading rate of 1.6 g COD per litre/d, a performance comparable with a conventional activated sludge plant. The biofilm and aquatic weed system was preferable to the more energy demanding biofilm process unless lack of land prevented its use. **USA**

95-1408

**Tertiary treatment of wastewaters by ultrafiltration**

S. F. BRAHITI (Université des sciences et technologies Houari Boumediène, El Alia), S. DAIKHI, D. ABDESSEMED, A. GAID and N. MAMERI

*Tribune de l'Eau* 1994, 47, No 571, 39-43 (in French)

A test rig supplied by the company Gamma Filtration was used to assess the effectiveness of an inorganic ultrafiltration membrane with a pore size of 1000 Å on an aluminium support for the tertiary treatment of secondary sewage effluent. The equipment termed the Microlab 130S is described, followed by an account of the results obtained at various pressures and flow rates (increased by recirculation of the permeate) and an estimate of the operating cost. The quality of the treated effluent was high, with a COD of 14 mg per litre (83 per cent reduction) and a BOD<sub>5</sub> of 5 mg per litre (98 per cent reduction) while bacterial counts were reduced to only 20 per 100 ml for total coliforms, 10 per 100 ml for *Escherichia coli* and 24 per 100 ml for Clostridia. Costs were estimated at 2 Dinars per m<sup>3</sup> of treated water. (English translation 160 pounds sterling valid for 1995). **Algeria**

95-1409

**Parameters affecting nitrifying biofilm reactors**

M. BOLLER (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf), W. G. JER and M. TSCHUI

*Water Science & Technology* 1994, 29, No 10/11, 1-11

Factors affecting nitrification in biofilms were examined theoretically. Experimental studies using plastic media trickling filters, rotating biological contactors and a range of aerated biofilters were used to illustrate the effects of various design and operational parameters which influenced the resulting fluxes of substances into and out of the biofilm and nitrifying activity in the biomass. Limitations in the use of these processes in tertiary nitrification applications and measures to enhance process performance were identified. A comparison of biofilm and activated sludge processes showed that the

former needed much smaller reactor volumes, but required higher energy inputs due to poor oxygen utilization. **Switzerland**

95-1410

**Biological aerated filters: assessment of the process based on 12 sewage treatment plants.**

J. P. CANLER (Centre National du Machinisme Agricole du Genie Rural, des Eaux et des Forêts (CFMACREF), Lyon) and J. M. PERRET

*Water Science & Technology* 1994, 29, No 10/11, 13-23

On site measurements were carried out at 12 sewage treatment installations using the biological aerated filtration process to evaluate process performance and analyse the efficiency of the filters. Other aspects such as energy requirements and backwashing were also examined. The process avoided the need for secondary clarifiers and its modular nature encouraged a wide variety of treatment applications. At applied loads of less than 7 kg of COD the effluent quality with a COD level of less than 90 mg per litre and a low level of suspended solids was satisfactory. Optimal operation required good correlation between the backwash frequency and the load treated. **France**

95-1411

**Upgrading of the Munich waste water treatment plants for denitrification in effluent filters**

J. LECHINGER (Landeshauptstadt München)

*Water Science & Technology* 1994, 29, No 12, 217-225

One cell of a bank of 24 effluent filters designed for removing suspended solids was evaluated for denitrification. Methanol was automatically dosed at 2.5-3.0 g per g nitrate nitrogen. Nitrate nitrogen of 10-15 mg per litre was removed at wastewater temperatures of 9-16°C without methanol breakthrough. BOD and suspended solids removals were good and effluent phosphorus concentrations were 0.1 mg per litre lower than in non denitrifying filters. Average hydraulic loads were 4.4 m per h but could rise to 14.4 m per h in storm conditions. Brief backwashing every 3.5 h released nitrogen gas which accumulated in the filter. The approach was an economical way of denitrifying effluents. **Germany**

95-1412

**Micro-straining as advanced treatment of wastewater applied to the main wastewater treatment plant in Wiesbaden**

A. GRAU (DAR - Deutsche Abwasser Reinigungs-Ges. mbH, Wiesbaden), M. HAUSELER and W. SCHMITT

*Water Science & Technology* 1994, 29, No 12, 237-245

Drum microstrainers were evaluated in a pilot plant treating secondary effluent. Meshes of 10, 20 and 40 µm, head differences of 35, 70, 100 and 150 mm and straining velocities of 10-35 m per h were examined, the range of the last 2 parameters depending on mesh dimensions. Effluent solids below 5 mg per litre were consistently attained. With a 20 µm mesh a straining velocity of 18-25 m per h and a head difference of 35-70 mm, 75-85 per cent retention of solids was achieved. Acid cleaning was necessary after a straining volume of 630,000 m<sup>3</sup> had been processed by each strainer. Backwash volume was about 0.5 per cent of the influent. The microstrainers were a cheaper option than sand filters. **Germany**



95-1413

## Tertiary treatment of urban wastewater by cross flow microfiltration.

M. F. POUET (Groupe de Genie des Procédés, Montpellier), A. GRASMICK, F. HOMER, F. NALLAU and J. C. CORNIER  
*Water Science & Technology* 1994, 30, No 4, 133-139

The cross flow microfiltration of secondary effluents was carried out in a pilot plant with multitubular membranes of porosity 0.2 µm. Product water was recirculated, backwashing took place every 2 minutes. Four effluents were tested whose origins were: high rate activated sludge with and without subsequent chemical treatment with aluminium salts, chemical treatment with aluminium salts and low rate activated sludge. Although effluents from chemical treatment contained more soluble COD than those from the biological processes, they fouled the microfiltration membranes less. The best flux was obtained with the alum dose which minimized supracolloidal COD in the effluent. This component appeared to be the principal cause of fouling. **France**

95-1414

## Performance of rotary disk modules in a collected human excreta treatment plant

N. OHKUMA (Hitachi Plant Engineering & Construction Co. Ltd, Chiba), T. SHINODA, T. AOI, Y. OKANIWA and Y. MAGARA  
*Water Science & Technology* 1994, 30, No 4, 141-149

Mixed liquor and coagulated sludge from an advanced sewage treatment activated sludge plant were treated by engagement type rotary disk membrane modules. The rotation of the modules ensured a rapid flow at the membrane surface which was normally achieved by a high rate of recirculation. Treated water was removed through the hollow shafts. The configuration of the disks obviated the need for baffles. With activated sludge solids of 12-18 g per litre, intermittent negative pressure operation at a disk peripheral velocity of 3.1 m per second maintained a flux of 0.9 m<sup>3</sup> per m<sup>2</sup> d for 8 months without chemical cleaning. For coagulated sludge, a peripheral velocity of 2.1 m per second maintained a flux of 1.6 m<sup>3</sup> per m<sup>2</sup> d for 7 months. The principal advantages of the system were low power demands and infrequent cleaning compared with tubular or plate and frame types. **Japan**

95-1415

## Treatment of municipal wastewater by a membrane bioreactor: results of a semi-industrial pilot-scale study.

E. TROUVE (Lyonnaise des Eaux Dumez, Le Pecq), A. URBAIN and J. MANFROT  
*Water Science & Technology* 1994, 30, No 4, 151-157

A pilot activated sludge plant operating at a sludge retention time of 25 d and a COD loading of 0.2 kg per kg volatile suspended solids was fed with screened domestic sewage from which grit and grease had been removed. After treatment the flow of 1840 m<sup>3</sup> per d was pumped to a 0.1 µm ceramic hollow fibre unit of filtration area 1.1 m<sup>2</sup>, protected by a 800 µm pre-filter. Excess permeate was recycled into the bioreactor. Average sludge production was 0.2 kg suspended solids per kg COD, 93-99.9 per cent of COD, suspended solids and ammonia were removed. The membranes required chemical washing every 15 d. The treated water was free from solids and effectively disinfected. **France**

95-1416

## a new unified solids flux-based approach for the design of final clarifiers: description and comparison with traditional criteria.

M. von SPERLING (Minas Gerais Federal University, Belo Horizonte)

*Water Science & Technology* 1994, 30, No 4, 57-66

A unified approach to sludge settleability, combined with results of previously published work, was simplified by classifying settleability as good, fair and poor, defined as sludge volume indices of 50, 100, 100-200 and 200-300, respectively. Ranges were also defined for alternative sludge settleability indices. The coefficients of the hindered settling velocity equation were also obtained for these classifications from literature data. The limiting flux was determined on the basis of the simplified approach. The algorithm and equations for clarifier design were readily computerized. The resulting maximal overflow rates and solids fluxes were in good agreement with those obtained by classical methods. **Brazil**

95-1417

## UV disinfection meets strict California standards.

A. FARRELL (Montgomery Watson, Walnut Creek, Calif.), D. CRAIG and L. PUTNAM

*Public Works* 1994, 125, No 11, 63-64

California's first major UV disinfection facility for treating secondary effluent had recently been approved to meet the state's stringent standards. The facility was under design at the Central Contra Costa Sanitary District's wastewater treatment works in Martinez. Extensive bench scale and pilot scale tests had been carried out over a year to evaluate the effectiveness of UV as an alternative disinfection method for non-filtered effluent. Layout of the pilot plant facilities is outlined and objective discussed. A cost comparison is also given. **U.S.A.**

95-1418

## A case study of wastewater plant disinfection

D. d'ADAM (Consoer Townsend Envirodyne, Chicago, Ill.) and W. BOWLES

*Public Works* 1994, 125, No 12, 40-41 and 70

The evaluation of a high resolution redox chemical feed disinfection system for potential use at Knollwood wastewater treatment works in Burr Ridge, Ill., is described. The disinfection was needed to help meet National Pollutant Discharge Elimination System requirements for chlorine residuals. System effectiveness was determined and performance was assessed with respect to chlorine residuals, faecal coliform counts, chlorine dosage and overall ease of operation. The high resolution redox system was based on potential created across a bipolar electrode, measured by a platinum electrode and a reference electrode. Following successful trial results, the system was installed and evaluated over the 1993 chlorination/dechlorination season. Although the system had not achieved significant usage savings, a tight control on chlorine and coliform levels had been maintained. **U.S.A.**

95-1419

## UV-disinfection of treated wastewater: possible effects on surface waters.

T. GSCHLOSS (Bayerisches Landesamt für Wasserwirtschaft, München)

*Water Science & Technology* 1994, 29, No 12, 255-266

The disinfection of effluent from wastewater treatment plants was studied in a pilot plant. The effluent of BOD and suspended solids

2 and 10 mg per litre, respectively was passed through a cloth filter then through 3 parallel UV systems of total electrical output 3.2, 3.5 and 9.0 kW, respectively. Flow was turbulent in the highest output system. Flows were 50-100 m<sup>3</sup> per h in the lower output system and 50-150 m<sup>3</sup> per h in the highest. Log reductions of total coliforms, faecal coliforms, faecal streptococci and total colonies were 4.0, 4.3, 3.9 and 3.3, respectively at 50 m<sup>3</sup> per h and 0.1-0.6 units lower at 100 m<sup>3</sup> per h. EC bathing water standards could be consistently achieved but further investigations were necessary to check that deleterious by-products were not formed. Mechanisms of UV disinfection and factors affecting its efficiency are discussed. **Germany**

95-1420

**Bioassays for full-scale UV disinfection systems.**

I. R. BLATCHLEY (Purdue University, West Lafayette, Ind.) and B. A. HUNT

*Water Science & Technology*, 1994, 30, No 4, 115-123

A UV bioassay was developed which measured the destruction of indigenous bacteria by UV irradiation. A relationship between the UV dose and the logarithm of *Escherichia coli* counts after and before irradiation was established. Dose was also estimated by numerical point source summation procedures. Where direct comparisons were possible in 2 plants, good agreement was obtained, the bioassay results being slightly lower. The application of both results being slightly lower. The application of both estimation techniques at full scale plants demonstrated that open channel UV disinfection systems could not be accurately modelled by plug flow or completely mixed models. Actual behaviour was intermediate, probably because of the 3 dimensional nature of the hydrodynamics and intensity distributions. A more accurate mathematical model was necessary. The bioassay test was easy to perform, used indigenous organisms and gave an accurate estimate of full scale performance. **U.S.A.**

95-1421

**Wastewater disinfection by UV at Trani municipal plant**

D. CARNAMEO (Ente Autonomo Acquedotto Pugliese, Bari), F. CONTINI, R. DEMARINO, F. DONADIO, I. LIBERTI and I. RANIERI

*Water Science & Technology*, 1994, 30, No 4, 125-132

Disinfection of secondary effluent with UV irradiation was compared in a parallel pilot plant with the existing disinfection by 30 mg sodium hypochlorite per litre solution containing 12 per cent active chlorine. The UV dose was 90 nW per cm<sup>2</sup> second at 253.7 nm. The sodium hypochlorite generated around 15 ppb of purgeable organic halide which increased with higher doses. The UV dose disinfected without harmful by-product formation. Regrowth in both light and dark conditions after irradiation never exceeded 1 log unit and was least at low temperatures. Costs were comparable for both processes. **Italy**

95-1422

**Microbiological study of two-stage anaerobic digestion during start-up.**

G. K. ANDERSON (Newcastle upon Tyne University), B. KASAPGIL and O. INCI

*Water Research*, 1994, 28, No 11, 2383-2392

The microbial population in a 2 stage anaerobic digester was studied in the laboratory in a pre acidification completely mixed reactor followed after pH adjustment by an upflow methanogenic filter with effluent recirculation. The reactors were seeded with digested sludge from a sewage works. Both stages were maintained at 35°C and fed

with wastewater from a milk bottling plant. Sludge samples were examined by epifluorescent microscope with illumination from a high pressure mercury lamp. The numbers of methanogens and non methanogens slightly decreased in the upflow filter, while the numbers of acidogens were almost constant in the pre acidification stage. Species dominance in the effluent from the filter varied from short rod to medium then back to short rod species. *Sarcina* and filament species attached to the biofilm in the filter. *Methanococcus*, *Methanobacterium*, *Methanobrevibacterium* and *Methanosarcina* species were among the autofluorescent methanogens tentatively identified in the filter. **U.K.**

95-1423

**Pathogen reduction capabilities of freeze/thaw sludge conditioning**

I. V. SANIN (Duke University, Durham, N.C.), P. A. VISHNIO and C. J. MARTIJ

*Water Research*, 1994, 28, No 11, 2393-2398

The effects of freezing rate, temperature and time in the frozen state on the removal of pathogens from aerobic and anaerobic sludges were investigated in laboratory experiments. Faecal indicator organisms and common parasites were measured. Storage temperature reduced the survival of viruses but had little effect on bacteria; conversely, viruses were unaffected by the rate of freezing while bacterial numbers declined most at higher freezing rates. A freezing period of 7 d was optimal for the removal of bacteria but viruses continued to decline up to 28 d. Further experiments with anaerobic sludge at a high freezing rate and a storage temperature of minus 25°C for 7 d gave low reductions for faecal coliforms, faecal streptococci, *Salmonella*, Poliovirus and *Cryptosporidium parvum* oocysts of 1.90, 0.21, 0.54, 1.08 and 8, respectively, with comparable results for aerobic sludge. *Acanthamoeba* were unaffected by freezing and thawing. **U.S.A.**

95-1424

**Dewatering of sewage sludges: a year's experience of the use of membrane filter presses**

E. MAYER (Société Ecnors) and G. GUIDEMANN

*Wat. Indust. Substances*, 1994, No 135, 45-47 (in French, English summary)

Dewatering of chemically conditioned sewage sludge at the Donau Riedlingen sewage works was formerly effected using 2 plate and frame filter presses which were capable of dewatering around 5000 tonnes of sludge per year treated with milk of lime and ferric chloride in amounts sufficient to enable a filter cake solids content of 40-42 per cent to be achieved. The need to increase throughput and the high capital cost of installing a third press dictated the installation of a new membrane type filter press, while the capacity of one of the original presses was increased by the addition of extra compartments. The new system thus consisted of a membrane press and a filter press of broadly similar dimensions (plate size 1200 mm by 1200 mm, applied pressure 10 bar, number of compartments 95 or 96, filtration surface 220 m<sup>2</sup>). The operation of these 2 presses is described and their performances during a 12 month period are compared. The membrane press proved to be superior to the plate and frame press, enabling a cake solids content of 50 per cent to be obtained instead of 40 per cent, with a substantial reduction in press cycle time (75 minutes in place of 120 minutes) and a consequent increase in output. The resulting saving in operating costs amounted to 100 000 DM per year. (English translation 65 pounds sterling, valid for 1995)

**Germany**

## INDUSTRIAL EFFLUENTS

95-1425

### Sludge dewatering at the Eften sewage works.

W. J. M. NIJBOER (Zuiveringschap (Oostelijk Gelderland)) and P. F. T. SCHYNS

*WZV*, 1994, 27, No 24, 716-717 (in Dutch, English summary, p. 701)

An economic evaluation was performed on alternative methods of dewatering a phosphate laden sludge at a Dutch sewage works. Gravity thickening, followed by physico-chemical treatment, and flotation thickening, would both necessitate costs for chemicals. Centrifugation and belt thickening were then compared for their capital and operating costs to arrive at a figure for the overall cost per ton of dried sludge produced. The method finally selected was a combination of a belt thickener with a decanter. (English translation 105 pounds sterling, valid for 1995) **Netherlands**

95-1426

### Why pit latrines fail: some environmental factors

R. REED (Loughborough University of Technology, U.K.)  
*Waterlines*, 1994, 13, No 2, 5-7

Although pit latrines were cheap, simple to install and operate, and easy to manage for rural communities in developing countries, they were not suitable in certain circumstances. Reasons for their failure are examined and environmental conditions where pit latrines were not appropriate are discussed. Issues such as ground infiltration, groundwater pollution and surface water pollution are examined. A mechanism is suggested for objective decision making, and for predicting the viability of pit latrines. **International**

95-1427

### Copper absorption by a schistic soil. Application of sewage sludge.

M. T. MESQUITA (Estacion Agronomica Nacional, Oeiras), J. M. VIEIRA e SILVA, and H. DOMINGUES

*Environmental Technology*, 1994, 15, No 11, 1089-1094

Copper was added to a sample of acid clay loam soil as copper nitrate (containing 3-100 mg copper per kg) or by incubation with urban sewage sludge (containing 26-260 mg copper per kg) for 2 weeks and the distribution of different fractions was determined by sequential chemical extraction. Data from total and specifically adsorbed copper fitted the Langmuir isotherm and desorbed copper was represented by a Freundlich isotherm. When small amounts of copper (up to 1 mg per litre) were added a larger proportion was specifically adsorbed (mostly by hydrous oxides of iron and manganese) where as more copper was in the exchangeable fraction when higher concentrations were added. The distribution pattern of copper in soil fractions appeared to be similar in sewage sludge and sludge-amended soil indicating that only a small amount of principally non-avaliable copper was transferred from sludge to soil within the study period. **Portugal**

95-1428

### Coal measure.

K. HAYWARD

*Water & Environment Management*, 1994, No 22, 24-25

Sludge disposal in Welsh Water's Gower area, Wales is discussed. Sludge was recycled to agriculture and also to the disused open-cast colliery at Maesgwyn to encourage tree growth during site remediation. The existing site at Llanelli released sludge to sea during the first hour of the ebb tide. This release will end with a new 18 million pounds treatment works. Other alternatives for sludge disposal that have been evaluated are composting in collaboration with the For-

estry Commission, tree planting on reclaimed land, and drying to produce a soil conditioner. The sludge injection system used at Maesgwyn is described. **U.K.**

95-1429

### Initial dilution of southeast Florida ocean outfalls.

J. R. PRONI (National Oceanic and Atmospheric Administration, Miami, Fla.), H. HUANG, and W. P. DAMMANN

*Journal of Hydraulic Engineering*, 1994, 120, No 12, 1409-1425

Field data concerning initial dilutions of 4 ocean outfalls on the east coast of south Florida (Miami-Central, Miami North, Hollywood and Broward outfalls) were analysed. Initial dilutions were obtained from dye and salinity studies. Both methods produced compatible values. Data for initial dilution and for environmental and effluent parameters were interpreted using the dimensional analysis method. Data for the Hollywood and Broward outfalls (single-port discharges) were consistent with data from previous studies, while data for the Miami-Central and Miami North outfalls (multi-port diffuser discharges) were not consistent with data for single-port discharges. **U.S.A.**

## INDUSTRIAL EFFLUENTS

See also Abstracts 95-1326, 95-1352, 95-1357, 95-1358, 95-1359, 95-1360, 95-1361, 95-1362, 95-1363, 95-1364, 95-1365, 95-1366, 95-1375

95-1430

### A new dimension for adsorption: hyper-adsorbent synthetic resins.

S. FEBRIERE (Puralite International) and O. MAURO HUN  
*Eur. Industrial Nourances*, 1994, No 1, 5-31-33 (in French, English summary)

The development of a new range of cross linked organic polymers of very high specific surface area, termed Macronet polymers, is described. These originated in 1969, as a result of the work of 2 Russian scientists (Dvanov and Issurupa) who patented their discovery. The polymerized skeleton of the material is subject to post-polymerization process producing a very open but highly cross-linked structure with a specific surface area of up to 1500 m<sup>2</sup> per g, as a result of which they are highly permeable to liquids and gases. Various active groups can be grafted onto the structure, making the resins suitable for a variety of ion-exchange processes and industrial reactions such as decolorization and emulsion breaking. The physical characteristics of several different grades of these resins are tabulated and some typical results from the use of Puralite Macronet MN200 resin for purification of air contaminated with low boiling solvents and amines are presented. (English translation 55 pounds sterling, valid for 1995) **France**

95-1431

### Chemical process wastewater treatment by attached cultures under anoxic conditions.

B. DELL'ANGHE (Ecole des Mines d'Alès), J. ROUSSY, E. GILHAL, and P. Le CLOIREC

*Water Science & Technology*, 1994, 29, No 10/11, 417-422

The anoxic biodegradation of wastewaters from wine-producing and chemical industries was investigated at pilot scale. Submerged granular filters with expanded glass balls as packing material for bacterial attachment were used. The nitrate requirements were deter-

nated on a semi-batch pilot unit. Nitrate consumption was around  $3 \times 10^{-9}$  per g of total organic carbon for organic carbon removal from the wine-production wastewater. Differences in the degradation kinetics and degradability of the organic compounds present in the 2 types of wastewater probably accounted for differences in the effects of volumetric loadings on total organic carbon removals. **France**

95-1432

**Treatment of organic wastewater by anaerobic fluidized bed reactor**

S. K. TSENG (National Taiwan University, Taipei) and M. R. CHEN

*Water Science & Technology*, 1994, 29, No 12, 157-166

Synthetic domestic and monosodium glutamate wastewaters were treated in a laboratory anaerobic fluidized bed reactor containing activated carbon. The synthetic wastewater contained chloro- or trophenol. COD removal efficiency above 70 per cent was achieved at temperatures above 21°C and loadings below 19 kg COD per m<sup>3</sup> d. Biomass concentrations were 13.3-40.2 g per litre. Treatment of the synthetic wastewater with a hydraulic retention time of 1 d and a loading rate of 0.9 kg compound per m<sup>3</sup> d. COD removal efficiency reached over 90 per cent. The compounds were mineralized or converted to metabolites. **Taiwan**

95-1433

**Characterization of industrial wastewater treatment dynamics using fast Fourier transform analysis**

F. BECARETS (Universidad de León) and A. J. GARCIA OLIVARES

*Water Science & Technology*, 1994, 30, No 2, 229-242

Influent, in-plant and effluent total COD concentrations in a 2 stage activated sludge pilot plant for nitrification/denitrification were subjected to time series analysis using a Fourier Transform procedure. The oscillations of effluent concentrations were principally dependent on the internal dynamics of the reactors. The output signal was more complex than the input owing to the shorter retention time in the first reactor. The second reactor reduced the complexity of the output but did not have an important effect on final total COD.

**Spain**

95-1434

**Fast-mode real-time simulator for the wastewater treatment process**

M. MIEZGLER (Silesia Technical University, Gliwice)

*Water Science & Technology*, 1994, 30, No 4, 191-197

A real-time simulator to assist industrial wastewater treatment plant operators decide how to deal with a slug of toxic material is described, using the example of cyanide at a coke oven installation. The mathematical model considered cyanide transport through the installation with the process units treated as stirred lumped parameter systems. It consisted of 27 non-linear differential equations which could rapidly be solved numerically on a personal computer. The application of the system is explained: it gave the operator an informed choice between storage of the high cyanide wastewater dilution with other flows, by passing or acceptance for treatment. **Poland**

95-1435

**Manure P fractionation**

G. M. BARNETT (Agriculture Canada, Lennoxville, P.Q.)

*Bioresource Technology*, 1994, 49, No 2, 149-155

The proportions of organic and inorganic phosphorus in animal manures is important from the point of view of their value as crop fertilizers. In this connection, samples of beef and dairy cattle manure were analysed to partition the faecal phosphorus into the phospholipid, inorganic, acid-soluble organic and residual forms using the McAuliffe and Peech (MP) method and a procedure developed by the Association of Official Analytical Chemists (AOAC) for flour. The AOAC procedure was more precise in terms of phospholipid phosphorus removal, was more rapid and had no effect on the other phosphorus forms. The MP method is suitable for the extraction of the inorganic, acid-soluble organic and residual phosphorus forms. **Canada**

95-1436

**A land-limited and energy-saving treatment system for dilute swine wastewater**

P. Y. YANG (Hawaii University at Manoa, Honolulu) and H. CHEN

*Bioresource Technology*, 1994, 49, No 2, 129-137

A combined bio-fixed film and aquatic plant procedure was developed, using series ponds and *Sublimo molesta* as the floating aquatic plant. Unlike the water hyacinth, which has been used as an aquatic plant in many wastewater treatment systems, *S. molesta* does not possess an extended root system, and obtains nutrients via the leaves. Trials on the system indicated that it could remove more than 90 per cent of the COD, 95 per cent of the total Kjeldahl nitrogen and 90 per cent of the total suspended solids. Among its advantages are its simple design and operation in addition to the moderate land requirements. Another advantage is the fact that the only energy required is for pumping to the system if a gravity flow system is designed and utilized. **U.S.A.**

95-1437

**Physico-chemical properties and productivity of two tropical soils amended with dehydrated swine waste**

J. S. C. MBAGWU (Nigeria University, Nsukka)

U. NAMBA, O. PARAH and G. O. NIVOH

*Bioresource Technology*, 1994, 49, No 2, 163-171

Two texturally contrasting soils (sandy and clayey) were treated with different rates of dehydrated swine waste (DSW) and an inorganic fertilizer to determine the productivity using maize (*Zea mays* L.) as an indicator. For both soils, high DSW application rates (5 per cent and above) delayed maize germination, with maize height and dry-matter yield increasing with increasing DSW application rate. Yields were consistently better on the clayey rather than on the sandy soil and increasing DSW application rates progressively increased the soil pH, organic carbon, nitrogen, phosphorus, exchangeable calcium, magnesium, potassium and cation exchange capacity, and reduced the exchangeable acidity at the end of the experiments. In general, DSW exhibits good potential for use in restoring the productivity of degraded soil. There are 32 references. **Nigeria**

95-1438

**Use of alkaline fly ash as an amendment for swine manure.**

M. VINCINI (Università Cattolica del Sacro Cuore, Piacenza), F. CARINI, and S. SILVA

*Bioresource Technology*, 1994, 49, No 3, 213-222

The influence of adding fly ash from coal-burning power stations to swine manure was studied in terms of its fertilizer value and polluting potential. In the experimental work, additions of 10 and 20 per cent (on a weight per volume basis) of the fly ash were made to the swine manure. The addition of fly ash did not inhibit microbial activity and respiration, and the carbon dioxide evolution from the amended swine manure was probably due to the high pH values caused by the fly ash addition, rather than stabilization of microbial activity. A feature of the study was the marked mobilization of inorganic phosphorus compounds in the fly ash which enriched the fertilizer value of the amended swine manure. This was accompanied by a marked loss of manganese and boron in the 20 per cent fly ash amended swine manure that would require consideration in terms of crop sensitivity and the boron content of the soil. There are 41 references. Italy.

95-1439

**Economic implications of phosphorus loading policies for pasture land applications of poultry litter**

R. GOVINDASAMY (Arkansas University, Fayetteville), M. J. COCHRAN, and F. HUCHBERGER

*Water Resources Bulletin*, 1994, 30, No 5, 901-910

In Arkansas approximately 1.5 million tons of poultry litter was produced per year, most of which was applied as a fertilizer to nearby pasture lands. Concern about the environmental impacts of increased nitrate, phosphorus and bacteria levels in water supplies, resulting from field application of poultry litter, had been growing in the state. No explicit state environmental policy on phosphorus handling existed. The economic opportunity costs of a proposed phosphorus management policy that targeted soils with elevated phosphorus levels are assessed. The impact of alternative tax policies e.g. Pigouvian taxes on optimal litter applications was studied. Litter application in the Muddy Fork watershed of the Illinois river, Ark., was studied. The results are discussed in terms of 4 scenarios: base output price scenario; output price sensitivity scenario; litter tax scenario; land (treated with litter) tax scenario. The restriction of litter applications on soils with elevated phosphorus levels would reduce the net returns generated from forage production, resulting in an environmental policy with a high opportunity cost for producers. Analysis of Pigouvian tax policies showed that a smaller tax per ton of litter applied could achieve the same litter control as that of a larger tax on a per acre basis. U.S.A.

95-1440

**Effect of H<sub>2</sub>O<sub>2</sub> addition mode on enzymatic removal of phenol from wastewater in the presence of polyethylene glycol.**

J. WU (Windsor University, Ont.), J. K. BEWTRA, N. BISWAS, and K. E. TAYLOR

*Canadian Journal of Chemical Engineering*, 1994, 72, No 5, 881-886

Batch and semi batch additions of the stoichiometric amount of hydrogen peroxide were used to examine the rate of phenol removal by horseradish peroxidase over the 1-10 µmol phenol per litre concentration range. The ratio between the maximal hydrogen peroxide concentration during the reaction and the initial horseradish peroxidase concentration controlled the phenol removal rate when polyethylene glycol was present. The optimal range for this ratio was

between 10 and 25 µmol hydrogen peroxide. For economic considerations a hydrogen peroxide addition mode should be selected which gives a compromise between having the fastest reaction rate and having the minimal number of hydrogen peroxide aliquots. Canada.

95-1441

**A question of excess.**

G. GARDNER

*Chemical Engineer*, 1994, No 578, 17-18

Global Environmental Services had established a regional and integrated treatment facility at Yorkshire Water's Knostrop site, for the pretreatment of industrial liquid waste to remove oils, metals and solids that would interfere with the downstream biological treatment processes. There were a number of treatment options, including ultrafiltration, neutralization, precipitation, oxidation, reduction, complex breaking, adsorption, dewatering and wet air oxidation. The facility would deal with 50 million gpd with a COD of 200 tonnes per d. Annually, 100,000 tonnes of effluent were treated, with wet air oxidation accounting for 5000 tonnes per year. Wet air oxidation was a very promising technology, and was capable of 60-85 per cent COD and 95 per cent toxicity removals. Removal of pesticides and agrochemicals was better than 99.9 per cent efficient. U.K.

95-1442

**Design steam strippers for water treatment.**

J. L. BRAVO (Jaeger Products Inc., Houston, Tex.)

*Chemical Engineering Progress*, 1994, 90, No 12, 56-63

Steam stripping is a distillation process for removing volatile organic compounds from water, and normally takes place at higher temperatures than is the case for air stripping. Frequently, steam stripping can often achieve high removal efficiencies (greater than 99 per cent) and effluent concentrations of below 5 ppb. Stripping is carried out in a tower with trays or packing to ensure contact between the steam and the contaminated wastewater, with stainless steel being suitable for most applications. A problem with such technology is the fouling of the recovery exchanger due to the deposition of inorganic salts, and in this context, provision must be made for frequent cleaning. Stripper design is a critical function of Henry's constant (or activity coefficient) for the target compound, and this constant must be determined from good experimental data on volatility and solubility. U.S.A.

95-1443

**Anaerobic digestion of a synthetic wastewater containing starch by a membrane reactor.**

Z. CADI (Institut national de la Recherche agronomique (INRA), Narbonne), H. HUYARD, J. MANEM, and R. MOLLTTA

*Environmental Technology*, 1994, 15, No 11, 1029-1033

A laboratory experiment with an anaerobic membrane bioreactor at a constant organic loading rate of 2 g per litre d showed that the COD removal rate decreased as the hydraulic retention time (HRT) was decreased from 135 to 6 h, reaching a minimum of 78 per cent at the 6-h HRT. When the solid retention time was maintained at 52 d and the organic loading rate was increased from 7 to 24 g COD per litre d, the volatile solids and volatile suspended solids (VSS) concentrations were proportional to the organic loading rate and the COD removal rate decreased. A COD removal yield of 87 per cent and specific removal rate of 0.57 g COD per g VSS d were achieved at an organic loading rate of 24 g COD per litre d. Membrane flux was 20-10 litre per h m<sup>2</sup> and was non-limiting below 40 g VSS per litre

but was near the upper limit at 74 g per litre when a flux of 4 litres per h m<sup>2</sup> was recorded for a linear velocity of 2.5 m per second France

95-1444

**Enhanced removal of phenol and m-cresol in PAC additional activated sludge system.**

I. TALJALI (Istanbul Technical University) and F. A. EL MABROUK

*Environmental Technology* 1994, 15, No 12, 1121-1134

The removal of toxic organic pollutants from wastewater was investigated using laboratory scale completely-mixed continuous flow powdered activated carbon activated sludge (PAC/AS) reactors operated with a hydraulic retention time of 16 h. During a 9 week period pollutant concentrations in a synthetic wastewater containing glucose were increased from 0 to 50 mg phenol per litre and 0 to 200 mg m-cresol per litre with sludge retention times of 5-20 d and mixed liquor PAC concentrations of 2000-6000 mg per litre. Enhancement of COD removal efficiency in the presence of PAC was attributed principally to the adsorption of non biodegradable compounds. Isotherm studies to examine PAC adsorbability showed that adsorption isotherms for phenol, m-cresol and glucose were described by a Freundlich equation. PAC dose, sludge age and PAC concentration were important variables and an AS mixed liquor carbon concentration greater than 2000 mg per litre was required to achieve a significant improvement in effluent quality. Empirical constants determined for phenol and m-cresol using a simple mathematical model could facilitate the prediction of PAC/AS system performance Turkey

95-1445

**Utilization of a bioluminescence toxicity assay for optimal design of biological and physicochemical wastewater treatment processes**

A. BRENNER (Ben Gurion University of the Negev, Sede Boker Campus), S. BEKIN, S. ULITZUR and A. ABU-LOVICH

*Environmental Toxicology and Water Quality* 1994, 9, No 4, 311-316

Tests were conducted using various configurations of biophysical processes to determine the feasibility of using biological and physicochemical treatments for complex wastewaters discharged by several chemical industries. Toxicity to bioluminescent bacteria (Microtox assay) was used to assess treatability of the waste sources and to provide quantifiable removability potential data defined by biodegradation or carbon removal. This removability data allowed identification of waste sources which were either only partially biodegradable or particularly toxic. Further work on these waste streams evaluated activated carbon adsorption using toxicity balances instead of chemical measurements. The Microtox assay was a convenient tool for evaluation of the processes used, but would require correlation to specific constituents for routine use Israel

95-1446

**Catalytic liquid-phase oxidation of phenol aqueous solutions. A kinetic investigation**

A. PINTAR (National Institute of Chemistry, Ljubljana) and J. LEVEC

*Industrial & Engineering Chemistry Research* 1994, 33, No 12, 3070-3077

Experimental work was carried out in a differential liquid full operated fixed bed reactor which employed a proprietary supported catalyst that consisted of copper, zinc and cobalt oxides to study the

liquid phase oxidation of aqueous solutions containing phenol. This catalyst which was most active when it was pretreated for 2 h at 860°C in oxygen and then cooled to ambient temperature was efficient in converting the phenol to benzenediols and benzoquinones, the C-4 intermediates via a total oxidation route, and carbon dioxide. The initial phenol conversion rate was described by a rate equation of the Langmuir-Hinshelwood type which accounted for both phenol and dissociative oxygen adsorption and a surface process that controlled the overall reaction rate Slovenia

95-1447

**Kinetics of wet air oxidation of glyoxalic acid and oxalic acid**

R. V. SHENDE (Bombay University), and V. V. MAHAJANI  
*Industrial & Engineering Chemistry Research* 1994, 33, No 12, 3125-3130

The use of a cupric sulphate catalyst was examined over a 120-245°C temperature range and an oxygen partial pressure of 0.345-1.380 MPa in an autoclave for the treatment of an aqueous waste stream containing a very high COD concentration. Cupric sulphate appears to be a very efficient catalyst for destroying glyoxalic and oxalic acids. Glyoxalic (both with and without the catalyst) obeyed first order kinetics with respect to the substrate (in terms of the COD) with 2 distinct steps. The second slow step suggested the greater resistance to further oxidation of the oxalic acid. Wet air oxidation of oxalic acid obeyed first order kinetics with respect to the substrate and resulted in the direct oxidation to water and carbon dioxide India

95-1448

**Comparative sorption equilibrium studies of toxic phenols on flyash and impregnated flyash**

B. K. SINGH (Indian School of Mines, Dhanbad), and N. S. RAWAT

*Journal of Chemical Technology & Biotechnology* 1994, 61, No 4, 307-317

The influence of various factors including particle size, flyash impregnation, pH and temperature on the sorption capacity have been examined for phenol, o-cresol, m-cresol, p-cresol, o-nitrophenol, m-nitrophenol and p-nitrophenol absorbed onto power station flyash. An aluminium nitrate solution (0.1 M) or a 0.1 M iron(III) chloride solution was used for the impregnation procedure. A feature of this study was the fact that as the sorbent particle size decreased from 150 to 45 µm the sorption of the various phenols increased since the sorption capacity was directly proportional to the total exposed surface and inversely proportional to the particle diameter for a non porous adsorbent such as alumina. Generally speaking phenols sorption was higher in the case of impregnated flyash as compared with untreated flyash India

95-1449

**Removal of phenol from coupling of talc and peroxidase. Application for depollution of wastewater containing phenolic compounds**

D. ARSEQUEL (Universite P. Sabatier, Toulouse), and M. BABOULENI

*Journal of Chemical Technology & Biotechnology* 1994, 61, No 4, 331-335

The enzymatic degradation of phenols was examined using a combination of horseradish peroxidase and hydrogen peroxide in the presence of an abundant, inert and low cost mineral support in the form of talc (hydrated magnesium silicate). As a result of the adsorption of the reaction products onto the talc, a protective effect on the enzyme was promoted, thereby prolonging its degrading performance.

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ance. Phenol degradation in the presence of the talc was extended thus leading to a lower residual phenol content (about 20 per cent) than was the case in the absence of talc (about 40 per cent). A combination of hydrophobic and hydrophilic talcs appeared to enhance phenol degradation and also activate the enzyme, thus exploiting the relative advantages of the 2 talc types. This combination of 2 talcs as the support medium was promising for the decontamination of wastewaters containing phenolic compounds. **France**

95-1450

### Kinetics of toluene degradation in a biofilm system under denitrifying conditions.

J. P. ARCANGEHI (Denmark Technical University, Lyngby) and I. ARVIN

*Water Science & Technology* 1994, 29, No 10/11, 393-400

The kinetics of toluene biodegradation in a biofilm system in denitrifying conditions were investigated, both singly and in the presence of a mixture of aromatic compounds (benzene, ethylbenzene and xylenes). With toluene as the sole substrate, the maximal utilization rate and the half saturation constant were in the ranges 1.3-1.8 per d and 0.1-1.7 mg per litre, respectively. On the basis of nitrite production, the average yield coefficient was 1.0 to 1.2 mg biomass per mg toluene degraded. The degradation of toluene was significantly reduced in the presence of a mixture of benzene, xylenes and ethylbenzene. **Denmark**

95-1451

### Comparative study evaluating removal mechanisms of hydrocarbons by fixed film versus suspended growth reactors

N. GALI (Technion-Israel Institute of Technology, Haifa)

*Water Science & Technology* 1994, 29, No 10/11, 531-535

Mechanisms responsible for the removal of hydrocarbons from wastewaters by rotating biological contactors and activated sludge representing fixed film and suspended growth reactors, respectively, were investigated. The influent to both systems contained 700 mg COD per litre, 140 mg BOD per litre, 7.5 mg phenols per litre and 32 mg hydrocarbons per litre in emulsified form. Both units reduced hydrocarbons by about 90 per cent. In the case of activated sludge, 70 per cent was removed by attachment to biosolids, while in the fixed film system 15 per cent was stripped to the atmosphere, 25 per cent was biodegraded and 50 per cent was removed with wasted sludge. Biosludge production and characteristics were significantly better with the fixed film system. **U.S.A.**

95-1452

### Degradation of starch particulates in a hybrid reactor

H. H. P. LANG (Hong Kong University) and T. S. KWONG

*Water Science & Technology* 1994, 30, No 4, 97-104

Starch slurry equivalent to 10 g COD per litre d was fed at 37°C, pH 7.2-7.5 and 12 h retention to an 8.5 litre upflow anaerobic reactor which was a hybrid between a sludge blanket and a filter reactor. The reactor was commissioned on a mixture of sucrose and corn starch and not fed exclusively with starch until granulation was established. The particulates had no deleterious effect on the reactor. Of the original COD, 5.8-82.5 and 11.7 per cent passed to the effluent, was converted to methane and became granular biomass, respectively. Average sludge yield was 0.09 g volatile suspended solids per g COD, methane production was 0.86 g per g volatile suspended solids d. The granules were layered: starch hydrolysing streptococci occupied the outer layer and acetoclastic *Methanotrix* the interior. **Hong Kong**

95-1453

### Modelling: Control of activated sludge plants on the basis of respirometry.

H. BROUWER (Wageningen Agricultural University), A. KLAPWIJK, and K. J. KEESMAN

*Water Science & Technology* 1994, 30, No 4, 265-274

Improvements to the operation of a carousel activated sludge plant treating varying loads from a flavour and fragrance factory were explored through respirometric measurements. The first compartment of the carousel, where readily biodegradable compounds (RBC) were treated, was modelled physically by an activated sludge unit which permitted respirometric measurements. A mathematical model was created to represent the biodegradation of the RBC, the physical transport of wastewater in the pump well and oil separator and the dissolved oxygen in different parts of the carousel. The influence of the wastewater on the actual respiration rate (ARR) and the effect of flow on it, from which the model was calibrated, were obtained from further experiments. Simulations of the system in a controlled and uncontrolled state were undertaken. These indicated that overloading could be prevented by controlling ARR through restricting the strong crude wastewater or the total wastewater flow; the latter was most effective. Closer control also yielded energy savings of 11-21 per cent. **Netherlands**

95-1454

### LRP method for treatment of waste water from non-wood soda pulping

Z. HE (SMT Espoo) and P. HYNINEN

*European Water Pollution Control* 1994, 4, No 6, 35-39

A lignin removal process (LRP), a physico-chemical treatment originally developed for effluent from wood based pulp and paper industrial processes, was extended to wastewater from non-wood soda pulping. Bagasse, wheat straw, reed and Chinese silver grass black liquors were examined. Fibre sludge was acidified to pH 1.3-1.6, mixed with dilute black liquor and the pH raised to 4.5-6.0. Subsequent sedimentation was aided by polymer addition or by centrifugation. COD reductions of 25-55 per cent and colour reductions of 40-85 per cent were obtained for bagasse and wheat straw. Lower removals were obtained for reed black liquor. Treatment efficiency was generally higher at initially high acidities, with mixed fibrous sludge and influent COD above 2500 mg per litre. Results were comparable with those from aluminium sulphate coagulation. **Finland**

95-1455

### Development of wastewater pretreatment flowsheet at the Selenginsk pulp-and-board integrated works prior to reverse-osmosis desalination

V. V. ZIMENKOV (VNPhumprom Institute, Saint Petersburg), S. S. SIMONOV, and L. M. EMANAKOVA

*Journal of Water Chemistry and Technology* 1994, 16, No 2, 24-30

Design and operation of a pilot reverse osmosis (RO) desalination unit at the Selenginsk pulp and board integrated works is reported. Derivation of a flowsheet (reported elsewhere) is described which permitted treatment of sewage to predetermined quality standards whilst maintaining stability of the physico-chemical parameters of operation of the RO membrane unit to prevent sedimentation. **Russia**

95-1456

**Anaerobic detoxification of a chemi-thermomechanical effluent by two acclimating sludges.**

A. PATOINE (National Research Council of Canada, Montreal, P.Q.), R. COTE, and M. PAQUET

*Water Pollution Research Journal of Canada*, 1994, 29, No. 4, 471-486

Toxicity and resin acid concentration in pulp and paper effluents can be decreased by anaerobic or aerobic biotreatment. Detoxification of a chemi-thermomechanical pulp (CTMP) effluent was examined by monitoring toxicity and resin acid concentration during treatment in batch reactors. Two sludges were used: (1) granular sludge from an upflow anaerobic sludge blanket reactor treating neutral sulphite semi-chemical pulp effluent; (2) sludge from an anaerobic digester on Valcartier military base, P.Q. The 2 sludges were acclimated to the CTMP effluent by successive 6 d suspended growth cycles on fresh effluent. Detoxification was achieved with both sludges during the last growth cycle, but it was not clear whether this was the result of bacterial activity or changes in the physico-chemical environment. Six growth cycles of 6 d were insufficient for a completely unacclimated sludge (the Valcartier sludge) to attain the same biogas production as that shown by a partly acclimated sludge (the granules). Both sludges appeared to show resin acid adsorption, making it impossible to tell how much was transformed and how much was adsorbed during a given growth cycle. There are 13 references. **Canada**

95-1457

**Paper mill effluent treatment using biofiltration**

J. M. ROVEL (Degremont S.A., Rueil, Malmison), J. P. TRUDEL, P. LAVALLÉE, and J. SCHROETER

*Water Science & Technology*, 1994, 29, No. 10/11, 217-222

The Biorfor co-current upflow biofiltration system was used to treat effluents from 4 different paper mills. These ranged from very dilute effluents from units producing fine papers using bleached cellulose to much more concentrated effluents from an integrated pulp and paper mill. The results demonstrated the potential and advantages of the process for this type of application: either as a complement to or replacement of the activated sludge process. The Biorfor process dispensed with the clarification step and offered good resistance to sudden fluctuations in load and flow rate. These characteristics make it particularly suitable for pulp and paper industry applications. **France**

95-1458

**Increase of efficiency of an activated sludge plant in paper manufacturing industry by application of a fluidized bed system**

J. SCHNEEBERG

*Water Science & Technology*, 1994, 29, No. 12, 177-183

The effluents from a paper mill were initially treated successfully by primary sedimentation, balancing activated sludge and final sedimentation until increasing loads dictated expansion. Restrictions on space prevented conventional extensions, so the treatment plant was uprated by introducing polyurethane foam into the activated sludge at 20-30 per cent of reactor volume. Further improvements were achieved by enlarging the balancing tank, automating the dosing of nutrients and better control of the draw-off of surplus sludge. The installation of a sand filter for the final effluent was also planned. This approach was successful although it required more skilful management than the previous treatment plant. **Germany**

95-1459

**Choice of the reactor type and ozonation conditions for concentrated wastewaters**

S. V. ZIMA (Civil Engineering Institute, Kiev) and A. K. BAKER

*Journal of Water Chemistry and Technology*, 1994, 16, No. 2, 21-23

Optimal conditions of ozone treatment of concentrated wastewaters were derived from studies of oxidation of synthetic dyes in counter-current, co-current, batchflow and continuous flow reactors. Ozonation was more efficient in a nonflow reactor with circulation and under co-current conditions similar to substitution reactors. **Ukraine**

95-1460

**Sorbent for purification of wastewaters from anionic dyes**

A. A. RYAZANTSEV (Buryat Institute of Natural Sciences, Ulan-Ude)

*Journal of Water Chemistry and Technology*, 1994, 16, No. 2, 47-49

Modification by ultrasound at 22 kHz for 3 minutes of natural montmorillonite in iron(III) solution produced a sorbent for the removal of anionic dyes and surfactants from wastewaters. Adsorption capacity of the product for the dye Direct Black was 0.6 g per g. **Russia**

95-1461

**The operating plant performance data for purification of sewage waters from azo dye production**

N. V. BRAZHNIKO (Kiev Polytechnic Institute), I. A. BOIKO, and A. S. KOROLYOV

*Journal of Water Chemistry and Technology*, 1994, 16, No. 2, 50-54

Performance data are presented for the purification of sewage effluents from azo dyes at the Sivashviline dye factory (SADF). Proposals for the modification of the works include substitution of iron(II) coagulant by pig iron filings and incorporation of an activated sludge stage. Pig iron filings permitted reduction of dye materials by atomic hydrogen. Final decolorization was achieved by electrolytic oxidation or by addition of potassium permanganate. Diagrams of original and modified works are included. **Ukraine**

95-1462

**Aerobic degradation of azo dyes in biofilms**

H. JIANG (Cincinnati University, Ohio) and P. L. BISHOP

*Water Science & Technology*, 1994, 29, No. 10/11, 525-530

Laboratory scale rotating drum biofilm reactors were used to investigate factors affecting the biological removal of azo dyes from a synthetic wastewater. Of 3 azo dyes studied, Acid Orange 8, Acid Orange 10 and Acid Red 14, only the first was degraded aerobically. Cleavage of the azo bond was achieved easily for all 3 dyes in anaerobic conditions. Removals of Acid Orange 8 ranged from 20-90 per cent. Maximal removal occurred at high bulk phase dissolved oxygen and low COD flux. Biofilm accumulation was affected by the presence of azo dyes and by such factors as COD loading, bulk phase dissolved oxygen level and shear force. **U.S.A.**



95-1463

## Mass-transfer mechanisms for zeolite ion exchange in waste-water treatment.

S. M. ROBINSON (Oak Ridge National Laboratory, Tenn.) W. D. ARNOLD, and C. H. BYERS

*AIChE Journal*, 1994, 40, No 12, 2045-2054

Experimental data from a batch reactor and theoretical models accounting for intraparticle diffusivities were evaluated in finite batch reactor studies using solutions containing caesium, strontium, calcium and/or magnesium that were contacted with chabazite zeolites (Ionsiv 90 and Ionsiv 96) which were initially in the sodium form. Ionsiv IE-90 particles are zeolite crystals, whereas Ionsiv IE-96 particles are zeolite crystals which are pelleted with a clay binder. The experimental data were in the form of uptake curves for both zeolite types, and were a function of the zeolite particle sizes. A ranking order for the selectivity of the elements was established such that caesium was greater than strontium was greater than calcium was greater than magnesium was greater than sodium. Only the model that accounted for micropore and macropore diffusion occurring in series accurately predicted multicomponent data using diffusivities from the binary system. There are 62 references. U.S.A.

95-1464

## Application studies of biosorption for monazite processing industry effluents.

T. R. MURALEEDHARAN (Indira Gandhi Institute of Development Research, Bombay), L. PHILIP, T. IYENGAR, and C. VENKOBACHAR

*Bioresource Technology*, 1994, 49, No 2, 179-186

The effluent from monazite processing contains heavy metals, phosphates, fluorides, rare earth elements and traces of the thorium radionuclide. In this context, bench scale studies with packed bed reactors using *Ganoderma lucidum* as a biosorbent in the downflow mode were carried out to determine the design criteria for the development of a prototype. Advantages of the biosorption treatment of monazite processing effluent include the capability for desorbing the elements using hydrochloric acid and returning them to the process stream, and the potential for using a single reactor for the uptake of the rare earths and the thorium. India

95-1465

## Waste microbial biomass for cadmium ion removal: application of flotation for downstream separation.

K. A. MATIS (Aristotle University, Thessaloniki), A. I. ZOUBOULIS, and I. C. HANCOCK

*Bioresource Technology*, 1994, 49, No 3, 253-259

Dead industrial waste biomass was used for biosorption of metals from dilute solutions in combination with flotation recovery to form an efficient treatment process. The 2 stage process involved the use of *Streptomyces lavuligerus*, which is a branched filamentous actinomycete, for the sorption stage, followed by flotation concentration with the addition of cetyl trimethylammonium bromide as a surfactant (collector) and ethanol as the frother. The result was metal (cadmium loaded biomass stream and a clean water underflow stream, with the cadmium being eluted with EDTA. Solution pH and ionic strength were important factors in the process, which was efficient (almost 100 per cent in certain cases) at pH values in excess of 5. Greece

95-1466

## Bioscavenging of Cu(II) ions from aqueous solutions with rice-bran.

N. VERMA (Punjab University, Patiala) and R. REHAL

*Bioresource Technology*, 1994, 49, No 3, 277-278

Rice-bran treated with a 1 per cent sodium hydroxide solution was used as a sorbent to remove copper ions from an aqueous solution of copper sulphate pentahydrate. Maximal copper adsorption was obtained at pH 7.2 and additionally, the divalent metal uptake appeared to be affected by the presence of sodium acetate and sodium chloride in a 50 ppm solution of the copper at pH 7.2. Typically, the adsorption at a 100 ppm copper(II) ions level was 94.3 per cent using 100 ml of the copper(II) solution and 1 g of the rice-bran with 1 h shaking period. Modified rice-bran was an efficient and cost effective substrate for removing heavy metal ions from industrial wastewaters. India

95-1467

## Further insight into the mechanism of biosorption of heavy metals by *Ganoderma lucidum*.

T. R. MURALEEDHARAN (Indira Gandhi Institute of Development Research, Bombay) and T. J. VENKOBACHAR

*Environmental Technology*, 1994, 15, No 11, 1015-1027

Selective elution of the cell wall components of the biosorbent wood rotting fungus *Ganoderma lucidum* indicated that the innermost layer of structural polysaccharides was responsible for 81.6 per cent of heavy metal uptake. Electron paramagnetic resonance (EPR) spectroscopy and energy dispersion analysis by X-ray of sorbent (EDAX) techniques using copper as the model metal demonstrated that most metal uptake was due to ion exchange with calcium and hydrogen. Preferential metal uptake was observed with oxygen-seeking elements. India

95-1468

## Removal of antimony(V) and antimony(III) from aqueous solutions: part I: co-precipitation and adsorption during flocculation with ferric iron salts.

R. ENDERS (TU, Berlin) and M. JEKEL

*WVE Wässer/Abwasser*, 1994, 135, No 11, 632-641 (in German, English summary)

Although antimony possesses chemical and toxicological properties resembling those of arsenic, there has so far been little or no published information on methods for its elimination, despite the fact that it may be present in industrial effluents in concentrations of several mg per litre. Reports of its occurrence in various types of wastewaters are summarized followed by an account of experiments designed to optimize the removal performance achieved by the action of small amounts of ferric nitrate solution, in the presence of various other inorganic constituents. The results indicated that the elimination of antimony(V) was pH sensitive, satisfactory results being obtained only under weakly acidic conditions, while sulphate and bicarbonate ions exerted strong negative effects on its removal. Under alkaline condition the adsorption of antimony(V) into the hydrated iron oxide floc was enhanced by the presence of calcium and magnesium ions. For the trivalent form antimony(III) good removal efficiencies were recorded throughout the pH range from 5.0 to 10.0 and these were virtually unaffected by quite high levels of inorganic constituents. (English translation 375 pounds sterling, valid for 1995)

Germany

95-1469

**Ecologo-technological principles of the choice of flocculants for wastewater purification from clay suspensions.**

S. S. TIMOFEEVA (Polytechnic Institute Irkutsk), A. M. BEIM, and A. A. BEIM

*Journal of Water Chemistry and Technology*, 1994, 16, No 1, 27-30

Physico-chemical (speed and efficiency of clarification) and toxicological data on 38 anionic, cationic and non ionic flocculant agents (FA) are tabulated. FA from Germany, Japan and Russia were assessed. Application of FA to the separation of montmorillonite by ferromagnetic clays is discussed. **Russia**

95-1470

**Oxidative purification of phenol-containing sewage waters from thermal treatment of shales.**

S. V. PREIS (Tallinn Tech. University), S. B. KAMFNEV, and Y. I. KALLAS

*Journal of Water Chemistry and Technology*, 1994, 16, No 1, 31-38

Oxidative purification by ozone and hydrogen peroxide of effluents containing phenol, *m*-cresol and 5-methylresorcinol, from gold mining dumps from the thermal processing of oil shales in Estonia is reported. Optimal pH for ozonation of individual phenols was determined from model solutions of phenols and wastewaters. Volatile phenols degraded faster. The catalyst in Fenton's reagent (iron(II) sulphate) affected reaction rate but not consumption of oxidant. Toxicity of treated wastewaters to *Daphnia magna* decreased as the proportion of added oxidant increased. **Finland**

95-1471

**Cornish pastiche.**

H. RUSSELL

*Water & Environment Management*, 1994, No 22, 29-30

In 1991 heavily polluted water from the disused Wheal Jane tin mine in Cornwall flooded the Carnon river and into Falmouth bay. As a temporary solution water was extracted from the mine and dosed with lime to reduce its pH and make the heavy metals insoluble. A flocculant was added which helped the metals settle out and the water was led through the tailings dam and into the Carnon. Three different systems of passive treatment were investigated in a pilot scheme. Pre-treated effluent flowed into a series of aerobic cells containing reed plants. Here iron was removed as iron hydroxide which in turn removed arsenic by absorption. Next in an anaerobic cell containing a mixture of cattle manure and sawdust cadmium, zinc, copper, some iron and sulphate were removed by bacteria as insoluble metal sulphides. The effluent was passed through a rock filter where manganese was removed. A study of the active treatment was also being conducted. **U.K.**

95-1472

**Treatment of water from an open-pit copper mine using biogenic sulphide and limestone - a feasibility study.**

R. W. HAMMACK (U.S. Bureau of Mines, Pittsburgh, Pa.), H. M. EIDENBORN, and D. H. DVORAK

*Water Research*, 1994, 28, No 11, 2321-2329

Acidic metal-contaminated water was treated in a laboratory system. Hydrogen sulphide generated in a bioreactor containing a mixed culture of sulphate-reducing bacteria was passed countercurrent through the wastewater in a reactor consisting of 9 chambers designed to prevent the downward movement of metal sulphide precipitates. The effluent then passed through a neutralization reactor

filled with limestone chips to raise the pH from 1.7 to above 5. Finally, the effluent with added nutrient passed through the sulphide-generating reactor. Metals were analysed by inductively coupled argon plasma emission spectroscopy. More than 90 per cent of the original iron, copper, zinc and aluminium at concentrations of 620, 178, 530 and 278 mg per litre respectively were removed; manganese was reduced by 91 per cent. The limestone eventually became inactive through precipitation of several compounds on its surface. There are 34 references. **U.S.A.**

95-1473

**Membrane technology of regeneration of effluents from filtration slime fields.**

L. F. KARDASHINA (Urals Research Institute of Chemistry, Yekaterinburg), S. I. LITPOLOVSKII, F. V. MIGALATII, V. N. NOVIKOV, and O. M. ROZENTAI

*Journal of Water Chemistry and Technology*, 1994, 16, No 2, 31-37

Conditions for the pretreatment, reverse osmosis (RO) desalination and regeneration of effluents from slime fields are reported. Selection of appropriate technology and chemical addition, degree of concentration achieved by RO and stability of concentrate are discussed. Studies of preliminary purification by soda softening and by iron coagulation are described. A process flowsheet is included. Optimal conditions of pretreatment, RO operation, soda softening and iron coagulation are tabulated. **Russia**

95-1474

**A review of advanced technologies for the complex treatment of oils (produced) water from offshore oil and gas facilities.**

D. HADFIELD (Cyclotech)

*Environmental Protection Bulletin*, 1994, No 033, 13-24

Technologies are reviewed which may come under consideration should produced water discharge legislation become more stringent (including a limit to below a 40 mg per litre free oil level). For this limit to be attained, centrifuges, rotary hydrocyclones, membrane systems and coalescers for enhanced separator performance may be considered. Possibly the only commercially available hydrocyclone is the Alstom-Neyrtec Dynalcan system, the largest of which has a capacity of 120 m<sup>3</sup> per h. Other restrictions that may be introduced include limits on dissolved organics discharge, elimination of heavy metals and radionuclides and a requirement for produced water reinjection. Also considered are potential technologies for meeting these requirements. **U.K.**

95-1475

**Local sorption purification of industrial wastewaters from phenol.**

S. M. RUSTAMOV (Institute of Theoretical Problems of Chemical Technology, Baku), P. I. MAKHMUTOV, and Z. Z. BASHIROVA

*Journal of Water Chemistry and Technology*, 1994, 16, No 2, 36-40

Sorption of phenol from wastewaters from the catalytic and thermal cracking and slow coking works at the Novobakinskii oil refinery (NOR) and Krasnodubskii production section of the Baku Lannery refinery is reported. Sorption capacities of the anion exchangers AV-17-ON, IDE-10P-ON, AN-21, AN-1, and activated carbon KAD-iodic were 33, 35, 23, 25, 12, 5, 15, 8, 11 and 40, 42 respectively. Regeneration of AV-17-ON and KAD-iodic saturated with phenol was achieved by regeneration with 10 and 5 per cent solution

## EFFECTS OF POLLUTION

of sodium hydroxide to give a 12- and 10-fold respectively increase in concentration of phenol as sodium phenolate. **Azerbaijan**

95-1476

### **Sulphide removal from seawater with waste catalysts.**

J. N. AL HAJJI (Kuwait University, Safat) and M. R. REIDA  
*Water Research*, 1994, **28**, No 11, 2377-2381

The removal of sulphide by waste catalysts used in ammonia synthesis in petrochemical plants was investigated in a batch reactor which recycled 20 litres of seawater through a packed bed of catalyst. The 6 catalysts tested varied in shape, density and chemical composition. The reactions were swifter in the presence of catalysts than for a homogeneous reaction. Low temperature shift catalysts which contained a mixture of copper, zinc and aluminium oxides were the most effective, with a sulphide half-life of 13 minutes. The reaction was zero order in sulphide concentration. The presence of oxygen increased reaction speed. The batch recycle reactor with large recycle ratio approximated to an ideal stirred tank reactor. **Kuwait**

95-1477

### **Use of silicotitanates for removing caesium and strontium from defence waste**

R. G. ANTHONY (Texas A&M University, College Station), R. G. DOSCHER, D. G. and C. V. PHILLIP  
*Industrial & Engineering Chemistry Research*, 1994, **33**, No 11, 2702-2705

A novel hydrated crystalline silicotitanate (TAM-5) was synthesized and used to remove radioactive isotopes from solutions containing up to 5 M sodium and across a pH range of less than 1 to greater than 14. The ion exchange experiments were carried out with 0.1 g TAM-5 in a 10 ml solution containing 100 ppm caesium and 20 ppm strontium. The silicotitanate was superior to other organic and inorganic ion exchangers for removing caesium and strontium from defence wastes, although no explanation for the decrease in selectivity at high pH values could be offered other than the unique structure of TAM-5. **USA**

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See also Abstracts 95-1098, 95-1140, 95-1161, 95-1162, 95-1165, 95-1167

95-1478

### **Toxicity of *Microcystis aeruginosa* peptide toxin to yearling rainbow trout (*Oncorhynchus mykiss*)**

F. G. HENCALLA (Zurich University, Switzerland), D. R. DIETRICH and C. SCHMATTER  
*Aquatic Toxicology*, 1994, **30**, No 3, 215-224

The toxic effects of the cyanobacterial toxin microcystin-LR on yearling rainbow trout (*Oncorhynchus mykiss*) was investigated. When exposed to aqueous concentrations of 8 to 16 mg freeze-dried *Microcystis aeruginosa* per litre, equivalent to the cell numbers arising in an algal bloom, the dose over 18 h was non-toxic to the fish. When gavaged with the equivalent amount of algae that would have passed through the gills in the 18 h test period the fish died within 96 h. The dose was 1440 mg of freeze-dried algae per kg of body weight. Oral uptake of freeze-dried algae at a single gavage dose of 110 mg per kg body weight was non-toxic, but the same dose administered 8 times at 12 h intervals killed the fish within 96 h. The results suggested that fish kills arising from cyanobacteria were due

to oral ingestion of algae during an algal bloom. There are 34 references. **Switzerland**

95-1479

### **The status of coral reefs in South Western Pacific Islands.**

L. P. ZANN (Great Barrier Reef Marine Park Authority, Townsville, Qld., Australia)

*Marine Pollution Bulletin*, 1994, **29**, No 1/3, 52-61

The status of coral reefs in Fiji, Tonga, and Western Samoa was assessed principally from unpublished sources. Human impact was greatest in Western Samoa and least in Fiji. Significant losses of coastal habitats, over fishing, pollution, and eutrophication had occurred in reefs with limited ocean exchange through rapid population growth and unplanned development. On high wet islands, erosion from changing land use had caused sedimentation and eutrophication of inshore reefs. Crown of thorns starfish infestations had occurred. Slow growing species and many inshore fish were endangered, some having become locally extinct. Environmental management and awareness were limited while technical and financial resources were lacking. There are 32 references. **Pacific Islands**

95-1480

### **Observations on coral reefs of Hainan Island, South China sea**

D. HEGGE (Forschungsinstitut Senckenberg, Frankfurt, Germany), V. NEUMANN and J. LI

*Marine Pollution Bulletin*, 1994, **29**, No 1/3, 84-89

Coral reefs had been surveyed in 2 recent expeditions to Hainan Island. Dynamite fishing had severely damaged large sections of reefs. Tourist hotels located on the beach were placing coastal marine fauna at risk. Conservation measures and the enforcement of existing legislation were urgently needed to restrict damage. The incidence of species (up to 5 locations are tabulated). **China**

95-1481

### **State of coral reefs in the Galapagos Islands: natural vs anthropogenic impacts**

P. W. GLYNN (Miami University, Fla., USA)

*Marine Pollution Bulletin*, 1994, **29**, No 1/3, 131-140

Coral communities were studied in the 1975-1976 in the Galapagos Islands to provide baseline data; surveys were regularly performed after 1982. Data were statistically examined by analysis of variance and the Kruskal-Wallis test. Before the El Niño (1982-1983) disturbance, low diversity coral communities and small actively accreting coral reefs were present on shallow shelves. The sea warming following El Niño caused 95-99 per cent coral mortality. The population of the large sea urchin *Lyudskia thomasi* was unaffected and subsequently spread on dead coral, effectively preventing its regeneration. In comparison with these effects, anchor damage, coral collection and damage by fishermen were of less importance unless such activities significantly increased. There are 48 references. **Galapagos Islands**

95-1482

### **Mining in northern Canada: expanding the industry while protecting Arctic fishes - a review**

A. D. FLEMING (Virginia Tech University, Blacksburg, USA)

*Ecotoxicology and Environmental Safety*, 1994, **29**, No 2, 229-242

Information on the sensitivity of northern Canadian fish to contaminants associated with mining is reviewed; the past and present performances of mines in controlling pollution are assessed and progressive mining techniques that can help minimize environmental risk are identified. At least 22 fish species with major commercial

recreational or subsistence value might be affected as the mining industry expands. The importance of prudent planning based on comprehensive mine-site evaluation, biological risk assessment and research was essential to reduce the threat of environmental damage. There are 101 references. **Canada**

95-1483

**Cytotoxicity of metals toward rainbow trout R1 cell line.**

H. SEGNER (Centre for Environmental Research, Leipzig), D. LENZ, W. HANKE, and G. SCHUURMANN  
*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 273-279

R1 cells, a fibroblast-like cell line derived from rainbow trout liver tissue, were exposed to 13 metal salts, and cytotoxicity was assessed by neutral red uptake inhibition. The toxicity ranking of the cationic metals was silver, mercury, cadmium, zinc, copper, nickel, and lead, and of the anionic metals was arsenite, dichromate, chromate, arsenate, selenite, and permanganate. The cytotoxicity of divalent metal cations was strongly correlated ( $r$  equal to 0.93) to their chemical solubility parameter. There was close correlation between these results and those obtained for the BF-2 cell line from bluegill sunfish. There was poor correlation between the *in vitro* results and *in vivo* LC50 results, particularly for copper, which accumulates in gill tissue causing damage not reflected in cytotoxicity tests. **Germany**

95-1484

**pH, hardness and humic acid influence aluminium toxicity to rainbow trout (*Oncorhynchus mykiss*) in weakly alkaline waters.**

D. T. GUNDERSEN (Oregon State University, Corvallis), S. K. STAMAN, W. K. SEIM, and L. R. CURTIS  
*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No 6, 1345-1355

The effects of exposing juvenile rainbow trout (*Oncorhynchus mykiss*) to various combinations of aluminium and hardness concentrations at pH levels between 7.14 and 8.58 were investigated. Aluminium induced mortality was greater at weakly alkaline pH (7.95-8.58) than at near neutral pH (7.14-7.64). This was attributed to the much higher filterable aluminium concentrations at weakly alkaline pH values. Growth results from 16 d hardness tests suggested that polymeric and colloidal forms of aluminium were more potent in restricting growth than soluble forms. Hardness and humic acid seemed to protect trout most against sub-acute aluminium toxicity. There are 34 references. **U.S.A.**

95-1485

**The effect of copper on the blood chemistry of *Clarias gariepinus* (Clariidae).**

H. J. van VUREN (Rand Afrikaans University, Auckland Park), M. van der MERWE, and H. H. du PRETZ  
*Environmental Toxicology and Environmental Safety*, 1994, 29, No 2, 187-199

*Clarias gariepinus*, acclimated for 5 months to experimental conditions, were exposed to copper concentrations as found in the Olifants river, Kruger National Park during summer (0.05 plus or minus 0.032 mg per litre) and winter (0.085 plus or minus 0.032 mg per litre) for 96 h in a continuous flow experimental system. Changes in blood chemistry including erythrocytopenia, leucocytosis, hyperglycaemia and hyperproteinemia were noted at 21 plus or minus 1 and 28 plus or minus 10. Fish showed physiological adaptation to environmental change which did not necessarily reflect normality. There are 48 references. **South Africa**

95-1486

**Effect of cadmium and ration level on oxygen consumption, RNA concentration and RNA-DNA ratio in two clones of *Daphnia magna* Straus.**

I. BARBER (Sheffield University), D. J. BAIRD, and P. CALOW  
*Aquatic Toxicology*, 1994, 30, No 3, 249-258

A possible cause of a rise in oxygen consumption with increase of environmental nutrient concentration was investigated using RNA concentration and RNA to DNA ratio as indices of tissue development. Two genotypes of *Daphnia magna* Straus, one with tolerance and the other with relatively high sensitivity to cadmium stress, were exposed to 0, 0.5 and 1.5 mg carbon per litre, as *Chlorella vulgaris* and subjected to cadmium concentrations of between 0 and 20 µg per litre. The effects of cadmium on oxygen consumption increase were examined to ascertain whether the toxicant effect was to increase the rate of protein synthesis, cause a reduced feeding rate, or both. The possibility of genotype variability was addressed with the use of the 2 genotypes. Cadmium caused an overall reduction in feeding in both clones, consistent with their relative sensitivities. A correlation was found between oxygen consumption and RNA concentration but none between respiratory rate and the RNA to DNA ratio. **U.K.**

95-1487

**Cadmium, metal-binding proteins, and growth in bluegill (*Lepomis macrochirus*) exposed to contaminated sediments from the upper Mississippi river basin.**

W. G. COPE (Iowa State University, Ames), J. G. WIENER, M. L. SITTINGER, and G. J. ATCHISON  
*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No 6, 1356-1367

Juvenile bluegill (*Lepomis macrochirus*) were exposed to river sediment contaminated with cadmium at concentrations in the range 1.3 to 21.4 µg per g dry weight. Each treatment had 3 replicates, each with 35 fish. Exposure to suspended sediment reduced growth, probably due to physical interference of sediment with feeding and toxicity in the treatments with the highest cadmium concentrations. Levels of hepatic non-thionein cytosolic cadmium, not bound by metal-binding proteins, in fish exposed to the 2 most contaminated sediments exceeded that in controls. Whole body cadmium concentration was the most sensitive indicator of cadmium exposure. There are 68 references. **U.S.A.**

95-1488

**Residues of total mercury in fish from two small lakes in the biosphere reserve of Schorheide-Chorin in Brandenburg, East Germany.**

T. MATTHEIS (Institute of Freshwater Ecology and Inland Fisheries, Berlin-Friedrichshagen), M. PIETRÖCK, and R. KRUGER

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 299-307

Total mercury was determined in white trunk muscle of fish from 2 small lakes, using flameless atomic absorption spectroscopy. In one lake, the mean concentrations were 0.549, 0.296, and 0.186 mg per kg for pike, roach and bream, respectively. The WHO defined concentrations below 0.2 mg per kg as normal for fish from uncontaminated fresh water. No definite source for the mercury contamination could be identified. The other lake had mean concentrations of 0.154, 0.088, 0.050, 0.063, and 0.073 mg per kg for pike, roach, bream, perch and eel, respectively. This level of contamination was probably due to diffuse airborne pollution. **Germany**

## EFFECTS OF POLLUTION

95-1489

**Evaluation of bis(tri-*n*-butyltin)oxide (TBTO) neurotoxicity in rainbow trout (*Oncorhynchus mykiss*). I. Behaviour, weight increase, and tin content**

K. TRIEBSKORN (Hohenheim University, Stuttgart), H. R. KOHLER, J. FLEMMING, T. BRAUNBECK, R. D. NEGLIE, and H. RAHMANN

*Aquatic Toxicology*, 1994, 30, No 3, 189-197

Swimming behaviour, uptake of tin and weight increase were determined in 3 week old hatchling rainbow trout (*Oncorhynchus mykiss*) exposed to 0.5 µg per litre and 2.0 µg/litre of bis(tri-*n*-butyltin)oxide (TBTO). The fish were maintained in a flow through system and examined after periods of 7 and 21 d. The reduction in weight increase, bioaccumulation of TBTO and uptake of tin in head and trunk tissue were all dose dependent. Fish concentrated TBTO by a factor of up to 900 from their test solutions. Compared with control fish, the increase in weight over 21 d was greatly reduced in fish exposed to 2.0 µg TBTO per litre. Fish exposed to TBTO swam greater distances for longer times and at higher speeds than control fish. TBTO exposed fish also showed a greatly reduced response to physical disturbance and swam at random, whereas control fish mostly swam parallel to the sides of the circular glass tank. (see also following abstract). Germany

95-1490

**Evaluation of bis(tri-*n*-butyltin)oxide (TBTO) neurotoxicity in rainbow trout (*Oncorhynchus mykiss*). II. Ultrastructural diagnosis and tin localization by energy filtering transmission electron microscopy (EFTEM).**

R. TRIEBSKORN (Hohenheim University, Stuttgart), H. R. KOHLER, K. H. KORTJE, R. D. NEGLIE, H. RAHMANN, and T. BRAUNBECK

*Aquatic Toxicology*, 1994, 30, No 3, 199-213

Three week old hatchling rainbow trout (*Oncorhynchus mykiss*) were maintained for 21 d in 0.5 mg per litre or 2.0 mg per litre concentrations of bis(tri-*n*-butyltin)oxide (TBTO) in a flow through system. Brain samples from the tectum opticum and optic nerve were taken after 7 d and 21 d exposure and prepared for examination by electron microscopy. The tectum opticum and optic nerve both showed lesions, which included vacuolization of myelinated sheaths, darkening of glia cells and nerve fibres, and necroses in regions of myelinated and non myelinated fibre. The number of dark cells in the stratum periventriculare of the tectum opticum also increased. In fish exposed to 2.0 mg TBTO per litre, tin was identified in endothelial cells and myelin sheaths by electron energy loss spectroscopy and electron spectroscopic imaging. There are 30 references. (see also preceding abstract). Germany

95-1491

**Interannual mixed function oxidase (MFO) activity in winter flounder (*Pleuronectes americanus*) from a coal tar contaminated estuary**

W. VIGNIER (Bedford Institute of Oceanography, Dartmouth, N.S.), J. H. VANDERMEULEN, J. SINGH, and D. MOSSMAN  
*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No 6, 1368-1375

Mixed function oxidase (MFO) activities in winter flounder (*Pleuronectes americanus*) in Sydney estuary, N.S., a coal tar contaminated estuary, were measured. Sex, age, state of gonadal maturation and other morphometric indices were also studied. Fish taken during the same month in 3 successive years at the same sites were used to control as many variables as possible. The MFO response

was broadly correlated with loadings of polycyclic aromatic hydrocarbons (PAH) measured concurrently in the bottom sediments, but MFO induction did not occur equally in all fish. Single-season or single-year data should be interpreted with caution. There are 35 references. Canada

95-1492

**Inhibition of the biological self-purification by chlorophenols, sodium dodecyl sulphate, and the complexing agents ethylenediaminetetraacetic acid and nitrilotriacetic acid.**

A. WESSLER (WFM Wassertorschung Mainz GmbH) and U. OBST

*Environmental Toxicology and Water Quality*, 1994, 9, No 4, 327-331

The enzyme activities of surface water samples were analysed, using linear dilution of the water samples. Inhibition of water samples could be detected when a plot of enzyme activity against dilution was non linear. Patterns of inhibition effects were compared with those produced by water samples spiked with 2-chlorophenol, 4-chlorophenol, sodium dodecyl sulphate, ethylenediaminetetraacetic acid or nitrilotriacetic acid (NTA). Only 2-chlorophenol and NTA caused severe inhibition of the tested enzymes. The effects of the inhibitory substances were reduced by adsorption onto water insoluble polyvinylpyrrolidone or activated carbon, or by oxidation with hydrogen peroxide. Germany

95-1493

**The 'World Prodigy' oil spill in Narragansett bay, Rhode Island, acute effects on macrobenthic crustacean populations.**

H. WIDBOM (Stockholm University, Sweden) and C. A. OVIATT

*Hydrobiologia*, 1994, 291, No 2, 115-124

A detailed description is given of the effects of the oil spill from the tanker 'World Prodigy' in June 1989 just outside the mouth of the West Passage of Narragansett bay, R.I., U.S.A. on macrobenthic crustaceans at 5 stations with a varying level of oil exposure, including one control site never reached by oil from the spill. Total amphipod abundance, the amphipod genus *Ampelisca* and ostracods retained on a 0.3 mm mesh showed significant differences between stations. The total amphipod abundance, dominated by *Ampelisca*, decreased by 86 per cent within the first 2 weeks after the spill at the most heavily impacted station (23 µg oil per g sediment dry weight); there were also significantly large amphipod decreases at 2 other stations, one of which had only trace amounts of oil. For amphipods of the genus *Corophium*, no significant differences between stations were detected. U.S.A.

95-1494\*

**QSAR models for predicting the acute toxicity of selected organic chemicals with diverse structures to aquatic non-vertebrates and humans**

M. C. CALLEJA (Ghent University), P. GELADI, and G. PERSOONE

*SAR and QSAR in Environmental Research*, 1994, 2, No 3, 193-234

A study of acute toxicity prediction used quantitative structure activity relationship (QSAR) models with the 38 structurally diverse organic chemicals of the Multicentre Evaluation of *In Vitro* Cytotoxicity programme. Ecotoxicity data were obtained from tests on 5 aquatic nonvertebrates and from published human lethal concentrations and doses and structural descriptors included 5 physicochemical properties and carbon-13 nuclear magnetic resonance data. The

QSAR models were developed using partial least squares projection to latent structures (PLS) or backpropagation neural (BPN) techniques and the results obtained indicated that the relationship between acute toxicity and molecular structure was generally better described by nonlinear than linear models. Values predicted by BPN models were generally closer to observed toxicities than those predicted by PLS nonlinear models and BPN models for aquatic crustacea performed better than those for human acute toxicity. The type of outlier compound differed between models for both pesticides and nonpesticides. The *n*-octanol/water partition coefficient and the heat of formation were the only 2 structural descriptors that were of common importance to humans and aquatic nonvertebrates. There are 87 references. **Belgium**

95-1495

**Monitoring biological effects of contamination in marine fish along French coasts by measurements of ethoxresorufin-*O*-deethylase activity.**

J. BURGOT (IFREMER Nantes), G. BOUQUENÉ, G. PENGRAZ, D. GODEFROY, J. LEGRAND, J. DIMIT, I. MARCO, J. VINCENT, Y. HENOX, QUEL. H. OGER, JEANNERET and F. GALGANI

*Ecotoxicology and Environmental Safety* 1994, 29, No 2, 131-147. Variations in ethoxresorufin *O*-deethylase (EROD) activity specifically induced by PCB, PAH and dioxins were monitored biannually since 1992 in 2 pilot sites along French coasts using *Chironomus lyra*, *Limanda limanda*, *Setrarius* sp. and *Mullus barbatus*. A rapid method was used to assay EROD activity determined on a pollutant gradient and results were interpreted on a microplate reader. Optimization of this strategy in a large coastal area is to be used. There are 49 references. **France**

95-1496

**Mechanism-based comparisons of acute toxicities elicited by industrial organic chemicals in prokaryotic and eukaryotic systems.**

J. S. JAWORSKA (Tennessee University, Knoxville) and T. W. SCHULTZ

*Ecotoxicology and Environmental Safety* 1994, 29, No 2, 200-213. Mechanism-related quantitative structure activity relationships (QSAR) were built with data from the *Escherichia coli* and *Photobacterium phosphoreum* endpoints for known mechanisms of reversible toxicity and compared with QSAR developed for the 2 best studied eukaryotic systems *Tetrahymena pyriformis* and *Pimephales promelas*. Except for 4 nitroaniline, which required activation to become the Michael receptor, all chemicals containing reactive substructures revealed excess toxicity over polar narcosis QSAR for *E. coli* endpoints. In this system, chloroacetic acid and ethyl chloroacetate also appeared bioreactive. The only mechanism that did not exist in the prokaryotic system was uncoupling of oxidative phosphorylation. Prokaryotic chemicals, except 2,4-dinitroaniline, did not exhibit excess toxicity over polar narcosis QSAR, possibly due to lack of mitochondria in prokaryotes. Halogen substituted short chain carboxylic alcohols showed variable toxicity mechanisms depending on the type of substitution and the system. There are 46 references. **U.S.A.**

95-1497

**Use of hepatic MFO and blood enzyme biomarkers in sand flathead (*Platycephalus bassensis*) as indicators of pollution in Port Phillip bay, Australia.**

D. A. HOLDWAY (Royal Melbourne Institute of Technology), S. E. BRENNAN and J. T. AHOKAS

*Marine Pollution Bulletin* 1994, 28, No 11, 683-695

Sand flathead (*Platycephalus bassensis*) were collected from 12 sites in Port Phillip bay, Australia, and analysed for hepatic ethoxycoumarin *O*-deethylase (ECOD) and ethoxresorufin *O*-deethylase (EROD) activities and serum sorbitol dehydrogenase (SDH) during a 3 year period. Significant enzyme induction generally occurred at sites closest to industrial and urban development. EROD activity at one site could be correlated with total freshwater inflow, possibly due to PAH contamination. High SDH concentrations, a marker of hepatic tissue damage, were associated with lower microsomal ECOD and EROD activities, showing that a test for tissue damage needed to be included with tests of enzyme induction when monitoring effects of pollution. There were no sex differences in SDH or ECOD activities, but there was a significant difference for EROD in one sampling period when activities of 47.0 and 28.4 pmol per minute/mg protein were found for males and females respectively. There are 34 references. **Australia**

95-1498

**Toxicity of organophosphate insecticides and their metabolites to the water flea *Daphnia magna*, the Microtox test and an acetylcholinesterase inhibition test.**

R. GALLI (MBT Umwelttechnik AG, Zurich), H. W. RICH and R. SCHOLTZ

*Aquatic Toxicology* 1994, 30, No 3, 259-269

The acute toxicity was examined for the organophosphorus insecticides thiometon and disulfoton, together with some of their metabolites, and including other organophosphorus insecticides for comparison. The tests conducted were *Daphnia magna* immobilization, Microtox and an acetylcholinesterase (AChE) inhibition assay. Disulfoton had a higher EC50 to *D. magna* than thiometon, with their PO analogues having a greater toxicity than their respective parent compounds. The toxicities of the PS analogues were higher than those of the parent compounds but less than the PO derivatives. In the Microtox test the PO analogues of disulfoton and thiometon had lower toxicities than their parent compounds. Some of the PO derivatives were stronger inhibitors of AChE activity than the parent compounds and disulfoton and thiometon showed no inhibition. A toxicological model used to predict the toxicity of thiometon and disulfoton, together with some of their metabolites, gave good correlation with toxicities determined using *D. magna* and the Microtox test. **Switzerland**

95-1499

***In vivo* incorporation of 1-carbon-14 acetic acid into liver lipids of goldfish, *Carassius auratus*, during gamma-hexachloro-cyclohexane exposure.**

P. B. SINGH (Sheffield University) and D. I. KIMI

*Aquatic Toxicology* 1994, 30, No 3, 247-248

Specimens of both sexes of goldfish *Carassius auratus* were exposed to 0.01 mg per litre and 0.1 mg per litre of gamma-hexachloro-cyclohexane (gamma-HCH) for a period of 4 weeks. On the final day, when in the reproductively active pre-spawning stage of their annual reproductive cycle, the fish were injected intramuscularly with 74 kBq carbon-14 radiolabelled acetic acid per specimen. The fish were killed 18 h after injection and examined for the effect of gamma-

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HCH on the conversion of acetic acid into total lipid and lipid fractions. *gamma*-HCH altered the incorporation of carbon-14 radiolabelled acetic acid into hepatic nonpolar and polar lipids of this species in a manner partly dependent on sex, thereby affecting synthesis of lipids required for ovarian recrudescence. There are 47 references. U.K.

95-1500

**Translocation of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin from adult female lake trout (*Salvelinus namaycush*) to oocytes: effects on early life stage development and sac fry survival.**

M. K. WALKER (Wisconsin University, Madison), P. M. COOK, A. R. BATTERMAN, B. C. BUTTERWORTH, C. BERINI, J. J. LIBAL, J. C. HUENAGLE and R. E. PETERSON

*Canadian Journal of Fisheries and Aquatic Sciences*, 1994, 51, No 6, 1410-1418

The signs of toxicity and lethal potency of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) during early lake trout (*Salvelinus namaycush*) development when lake trout eggs were exposed to maternally derived TCDD were investigated. The signs of toxicity during early development were similar for waterborne, injection and maternal routes of TCDD exposure. The symptoms associated with the dose-related increase in sac fry mortality for all exposure routes resembled blue sac disease, including yolk sac oedema, cranio-facial alterations and arrested development. There are 57 references. U.S.A.

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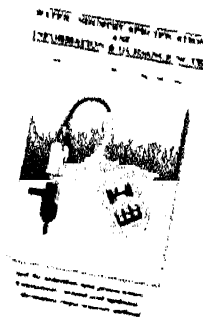
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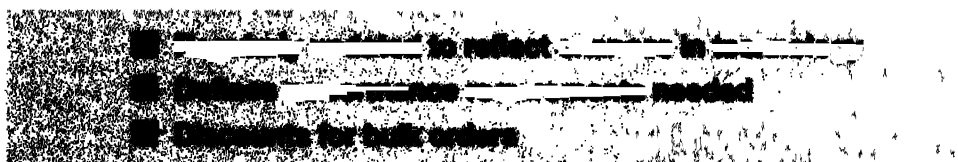
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**4-00-00 & 5-00-00**  
***For pipeline products and materials***  
***Revised to encompass explanatory notes on***  
***the emerging European Standards***



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AQUALINE

ABSTRACT

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## WATER RESOURCES AND SUPPLIES

storm sewage overflows and industrial discharges needed to be considered. U.K.

### 95-1507\*

#### **There is more to a successful biosolids land application programme than meeting the regulatory requirements.**

J. WALSH (Sydney Water Board, Burwood) and L. RAWLINSON

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.* The regulatory controls and codes of practice applicable to the disposal of sewage sludges in New South Wales are reviewed, with reference to the interim provisions of the N.S.W. Code of Practice for the Use and Disposal of Biosolids Products to Land. The provisions of this Code and their relevance to sludge disposal operations at all stages from the point of origin to the final incorporation into the land are discussed. Special consideration is given to the important aspects of product quality, transport requirements and public acceptance of the practice of sludge disposal to land, and numerous problems which can arise where there is insufficient attention to detail are highlighted. **Australia**

### 95-1508\*

#### **Effluent quality criteria for sewage treatment plants**

P. MARUZAN (New South Wales Environment Protection Agency, Bankstown), J. SPARKES and D. ELLIOT

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.* The policies and principles governing the development of Australian national water quality management strategies are reviewed; these are reflected in effluent quality criteria for discharges of sewage to natural waters and assume either the use of accepted modern technology (AMT) including tertiary treatment and biological nutrient removal, or intermediate technology, providing less stringent conditions where either the cost of AMT methods would be excessive, or inapplicable for certain reasons. In addition the criteria differ according to whether discharges are made to inland waters or ocean water, while separate conditions apply to near shore and offshore deepwater discharges. The manner in which these conditions were being imposed, and their application in the case of new plants, and also to existing plants in need of upgrading, is outlined. Where evidence of sewage-derived pollution existed, the agency might determine the nature and time scale of a programme for pollution abatement, in addition to setting quality standards with which the effluent must comply. **Australia**

### 95-1509

#### **Implications to water suppliers and householders of the new WHO guidelines for drinking water quality**

*Aqua*, 1994, 43, No 6, 315-322

In response to the revised World Health Organization guidelines for drinking water quality, EUREAU produced a position paper dealing with the implications of the changes for water suppliers, householders and manufacturers. Parameters which were likely to cause difficulties were lead, bromine, boron, arsenic, nickel, copper and antimony. Other parameters with new recommended guideline values are discussed and include nitrate and nitrite, pesticides, disinfectants and disinfection byproducts, organic compounds, and aromatic hydrocarbons. **Europe**

### 95-1510

#### **Reversing the tide.**

A. KING

*World Water and Environmental Engineering*, 1994, 17, No 10, 23 and 30

Historically, Italy and Greece had given a very low spending priority to water and wastewater. Under the Galli Law, Italy's complex water sector would be streamlined and made more efficient through a new system of integrated water resources management and user basins. Investment in environmental pollution schemes should indirectly benefit coastal and marine waters. Investment costs and equipment needs are considered. Marine and coastal pollution was a threat to Greece. Recent studies showed that most toxic industrial discharges generated by industry in the Saronic gulf and Therman gulf areas were disposed of untreated into the Mediterranean sea. A number of municipalities on the Attika coast had formed a private company to manage and access EU funds for environmental projects in the area. Most plant and equipment would need to be imported because no significant local environmental equipment industry existed in Greece. Some key factors for succeeding in the Italian and Greek markets are listed. **Europe**

### 95-1511\*

#### **The development of activated sludge computer models for training and process optimization**

K. LINDREA (La Trobe University, Bendigo, Vic.) J. DOUGLASS, R. RAMADORI and M. C. TOMELI

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.* The availability of activated sludge process simulation models offers scope for improving the general standard of sewage treatment by means of training for operating and management personnel and via process optimization. Conditions vital to the reliable application of these models are outlined, namely an understanding of the assumptions involved and the limitations thereby incurred for the validity of the model, together with a grasp of the structure and capabilities of the models concerned. Opportunities for improved access to modelling facilities in Australia are indicated, and the nature of 2 multidisciplinary courses for water industry professionals designed to improve their level of understanding and familiarity with modelling of the activated sludge process is outlined. These courses make use of computer software as a means of enhancing the level of experience of the trainees in both the conceptual and mathematical aspects of the modelling process. One is based in Perugia, Italy, and the other at La Trobe University, Bendigo. **Australia**

### 95-1512\*

#### **Education in the waste water treatment industry.**

L. M. SEVIOUR (La Trobe University, Bendigo, Vic.) K. C. LINDREA, R. J. SEVIOUR, J. A. SODDELL and H. M. STRATTON

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.* To provide facilities for education and training of personnel engaged in the design, erection and operation of biological sewage treatment installations, the Biotechnology Research Centre at La Trobe University, Bendigo, Vic., was now offering 2 regular courses. These were designed to instruct persons engaged in various aspects of the sewage treatment operations in the scientific principles underlying both conventional and advanced treatment methods, including those

for biological nutrient removal, and in methods for the identification of bacteria responsible for the formation of bulking sludge  
Australia

95-1513

**Development of charges and contributions to the costs of operation of sewage treatment plants in North Rhine-Westphalia.**  
R. PIENS

*Korrespondenz Abwasser*, 1994, 41, No 11, 2062-2064 and 2066-2068 (in German, English summary)

Charges for sewerage services in the province of North Rhine-Westphalia had risen dramatically during the last 3-4 years, arousing a storm of protest from various groups who considered they were being unfairly penalized for factors outside their control. There had been numerous press reports and articles criticising the rise in charges in various parts of the state, although they varied widely from one sewage undertaking to another. An outline of the basis on which the charges were calculated, and of the breakdown into various components is presented, showing that the largest proportion was represented by interest and depreciation charges, their actual proportion of the total ranging from 43.7 per cent in Gelsenkirchen to 21.9 per cent in Duisburg. Other principal cities and districts in different parts of Germany had much lower charges of this nature and there were also much lower average charges in Baden-Württemberg and in the countries bordering Germany on the west and north (France, Luxembourg and The Netherlands). The factors contributing to these anomalies are discussed. There are 30 references. (English translation 300 pounds sterling, valid for 1995). Germany

95-1514

**Golden share - a slice of the action?**

P. GARRETT

*Utility Week*, 1994, 16 December, 18-19

More merger and acquisition activity was expected among regional electricity companies than among generators or water service companies when the government gave up its stage in both sectors. The vulnerability of the different water companies to takeover is assessed. U.K.

95-1515

**Living with the MMC.**

P. GARRETT

*Utility Week*, 1994, 16 December, 20-21

According to the managing director of South West Water, there had been a massive investment programme since privatization. The company asked for a Monopolies and Mergers Commission (MMC) referral over its £ determination which the company felt would not enable it to adequately finance its future obligations. The referral process was very detailed and the company established a special project group to handle the workload. The MMC's view on the determination and a judgment on infrastructure charges was expected in March 1995. U.K.

95-1516

**Eastern promises hard to keep.**

*Water & Environment International*, 1994, 3, No 31, 16-17

The legal framework was in place to enable equal environmental conditions throughout the unified territory of Germany to be achieved by the year 2000. However, a huge investment was necessary to ensure compliance with drinking water standards. Sewerage and wastewater treatment were estimated to require 100-150 billion DM. The timescales for implementation appeared difficult to

achieve, so many communities were opting for private sector solutions. Germany

95-1517

**Standards of service continue to rise.**

*Water News*, 1995, No 59, 1-4

OFWAT's fifth annual report on levels of service of the water companies showed that the overall improvement recorded in previous years had continued. Companies were more customer-oriented. Responses to complaints and billing queries were made more quickly. There was a reduction in pressure problems and there had been no water restrictions. There were plans to extend the existing 7 official levels of service indicators. U.K.

95-1518

**Potential impacts of climatic change and of sea-level rise on the yields of aquifer, river and reservoir sources.**

J. A. COLE (WRc plc, Medmenham), D. B. OAKES, S. SLADE and K. J. CLARK

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 6, 591-606

A simple water-balance model was used to generate runoff sequences and simulate the yield/storage behaviour of reservoirs in south-east England, north-west England and North Wales under various climatic changes and sea level rises. The model employed regional statistics of daily rainfall and was adjusted to scenarios of the year 2030 rainfall and evaporation. The model results were interpreted and compared with surface reservoir examples. Coastal sea-water intrusion was modelled for the Grimsby Chalk, the Brighton Chalk and the Otter Valley sandstone aquifers. The importance of estuarine fresh salt water interfaces in the abstraction regime of freshwater intakes in the lower reaches of rivers is also considered. U.K.

95-1519

**Possible climate-change impacts on water supply of metropolitan Boston.**

P. H. KIRSHIN and N. M. FENNELLY

*Journal of Water Resources Planning and Management*, 1995, 121, No 1, 61-70

The possible impact of climatic changes resulting from a doubling of levels of atmospheric carbon dioxide on the water supply of metropolitan Boston was assessed. Serious decreases in reservoir system safe yield were predicted by scenarios embodied in some general circulation models. Temperature increases and a longer growing season resulted in severe impacts, though these might be mitigated by increases in vegetation canopy evapotranspiration resistance due to carbon dioxide enrichment or in precipitation. Streamflow decreases and downstream flow maintenance requirements would give rise to lower reservoir yield. Other scenarios predicted an increase in safe yield through large increases in precipitation. U.S.A.

95-1520\*

**Sensitivity of water resources in the Delaware river basin to climate variability and change.**

M. A. AYERS, D. M. WOLODCK, G. J. McCABE, L. E. HAY and G. D. TASKER

*U.S. Government Printing Office, Washington, D.C., Geological Survey Water Supply Paper No 2422*, 1994, 42pp

As a result of the so-called greenhouse effect, projected increases in the levels of carbon dioxide in the atmosphere were widely expected to induce global warming, which could in turn give rise to changes



## WATER RESOURCES AND SUPPLIES

in precipitation patterns, rates of evapotranspiration and an increase in sea level. This report describes the reasoning behind these predicted changes and discusses the problems and uncertainties associated with the prediction and effects of climate change. It also presents the results of sensitivity analyses showing how climate change might effect water resources and related hydrological characteristics including aquifer storage in the Delaware river basin together with the possible rise in sea level and extent of coastal inundation along the southern shore of New Jersey where the coastal swamps were vulnerable to intrusion from the sea. U.S.A.

95-1521

### Seasonal distribution of heavy rainfall events in Midwest

J. R. ANGEL (Midwestern Climate Center, Champaign, Ill.) and F. A. HUFF

*Journal of Water Resources Planning and Management*, 1995, 121, No 1, 110-115

The behaviour of heavy rainstorms in the U.S. Midwest and their hydrological impact are considered in relation to seasonal factors. Summer was the dominant season for extreme rainfall in the northern states, with the other seasons contributing more to total precipitation in the central and southern states. In Kentucky, southern Illinois and Indiana, winter precipitation approached that of summer in magnitude. The importance of this with respect to soil moisture is discussed. The combination of large winter rainfall events and near saturated soil conditions could produce high runoff. A systematic understanding of seasonal rainfall frequencies could contribute to better water control design procedures. U.S.A.

95-1522\*

### Flood of April 1987 in Maine

R. A. FOUNTAIN and J. P. NELSON

U.S. Government Printing Office, Washington, D.C. Geological Survey Water Supply Paper No. 2424, 1994, 50pp

This report presents a detailed hydrological and meteorological account of the severe flooding which caused widespread devastation in Maine, U.S.A., in April 1987. Two storm events associated with meltwater from the residual snowpack resulted in record peak flows at 13 gauging stations, some of the peaks being the highest ever known since the area was settled over 200 years earlier. Precipitation, snow cover, temperature, streamflow and reservoir storage before and during the flood are documented and the storm characteristics are outlined with reference to data from the state wide rainfall recording network and the National Weather Service. In addition the relation of the 1987 flood to previously recorded flood events is discussed. Reservoir systems in the headwaters of some of the principal rivers reduced the severity of the flood peaks in certain areas. U.S.A.

95-1523

### Stochastic estimation of plant-available soil water under fluctuating water table depths

D. OR (Utah State University, Logan) and D. P. GROENFELD

*Journal of Hydrology*, 1994, 163, No 1/2, 43-64

A predictive model was developed for soil available plant water in the presence of a shallow water table. The model was applicable to conditions in the Owens valley, Calif., where reliable predictions of plant water use were required to preserve native valley floor phreatophytes while pumping water for export from the valley. Statistical inputs for the model were estimated from available data. A scheme based on soil water balance coupled with implementation of Kalman filtering was used to provide soil water storage estimates and reduce

overall uncertainty. The proposed predictive model provided reliable and resilient soil water estimates in a wide range of conditions. U.S.A.

95-1524

### Infiltration mechanisms related to agricultural waste transport through the soil mantle to karst aquifers of southern Indiana, U.S.A.

M. Z. IQBAL (Indiana University, Bloomington) and N. C. KROTH

*Journal of Hydrology*, 1995, 164, No 1/4, 171-192

A field investigation was conducted in the clay soil mantle of a limestone terrain in southern Indiana to determine modes of soil water infiltration contributing to rapid transport of nitrate to the saturated zone. Profiles of nitrate concentration against time showed a consistent increase at various depths in the unsaturated zone during the study period. Asymmetric profiles of nitrate concentration against depth suggested the existence of preferential flow through macropores in the clay soil mantle above the bedrock. The significance of lateral mixing in a karst aquifer when vertical recharge was minimal, as in the dry summer of the study period, was also examined. U.S.A.

95-1525

### Prediction of surface water turnover time in coastal waters using digital bathymetric information

J. PERSSON (Uppsala University), L. HAKANSSON and P. PILLSJO

*Environmetrics*, 1994, 5, No 3, 433-449

A new type of geographical information system using digital bathymetric information was developed as a planning tool for coastal waters. The median turnover time of the surface water, which was equivalent to the ventilation constant, could be estimated in many cases from digital chart information. A digital technique for transferring information from standard charts into morphometric parameters showing various characteristics of the coast was used. More than 90 per cent of the variation in empirical values of surface water turnover times could be statistically explained by the degree of exposure of the coastal area to the open sea or adjacent coastal areas. There are 31 references. Sweden.

95-1526

### Nearshore waveheight during storms

M. J. TUCKER

*Coastal Engineering*, 1994, 24, No 1/2, 111-136

Storm waves generated locally over deep water and travelling into shoaling water are considered theoretically. It was assumed that the deep water wave spectrum was of the JONSWAP form, approximated by the Phillips spectrum with the same significant wave height. This spectrum was carried ashore, provided breaking operated to produce a constant spatial steepness. The resulting formula for significant wave height was simple and agreed closely with the values computed from the finite depth equivalent of the JONSWAP spectrum, the TMA spectrum. The formula was used to predict 50 year maximal wave heights and nearshore wave heights in a storm. The predictions were very close to observational data for the U.K. coast at Holderness. U.K. U.K.

95-1527

**The impact of conservation on a sea-defence scheme at Pennington.**

D. J. MARTIN (National Rivers Authority, Worthing)

*Journal of Institution of Water and Environmental Management* 1994, 8, No 6, 567-575

The reconstruction of 8.1 km of deteriorated sea wall along the Hampshire coast at Pennington by the Southern Region of the National Rivers Authority is described. The new wall protected an extensive area of land, much of which was a site of special scientific interest, between Lymington and Keyhaven. Planning and construction of the sea defences are discussed with particular reference to preservation and environmental concerns. The different phases of the scheme are detailed. Benefits and costs are also considered. The scheme was completed in 1993. U.K.

95-1528

**Peak discharge for small agricultural watersheds.**

R. H. HOTCHKISS (Nebraska University, Lincoln) and B. F. McCALLUM

*Journal of Hydraulic Engineering* 1995, 121, No 1, 36-48

Peak discharge estimation methods suitable for small agricultural catchments in Nebraska were investigated for use in the design of highway culverts. Time of concentration methods were analysed because of the importance of this parameter in many peak flow methods. Seven equations for time of concentration were compared with recorded values from 4 small catchments. Six peak flow methods were then studied in relation to recorded peaks to determine the best estimation method. A modified form of the Kirpich equation and the U.S. Soil Conservation Service average velocity equation estimated the time of concentration adequately. Peak discharges were best predicted using statewide regression equations, the Fletcher method and the rational method. U.S.A.

95-1529

**Streamflow generation on a small agricultural catchment during autumn recharge: I. Nonstormflow periods**

H. B. PIONKE (U.S. Department of Agriculture, University Park, Pa.) and D. R. DeWALLE

*Journal of Hydrology* 1994, 163, No 1/2, 1-22

The isotopic signature and chemistry of streamflow, springflow, seepage, soil water and shallow groundwater in a small hilly agricultural catchment in east central Pennsylvania were examined. The catchment was characterized by moderately deep, medium textured mineral soils with large water storage underlain by fractured rock with little storage, near stream seep zones and some perched water tables. The chemical and isotopic response of the non-storm stream flow during the autumn transition period and its relation to near-stream and spring sources of streamflow were determined. The non-storm chemical and flow framework for determining the chemical response of storm flow was established (see also following abstract). U.S.A.

95-1530

**Streamflow generation on a small agricultural catchment during autumn recharge: II. Stormflow periods.**

D. R. DeWALLE (Pennsylvania State University, University Park) and H. B. PIONKE

*Journal of Hydrology* 1994, 163, No 1/2, 23-42

Two- and 3-component tracer models were used to determine stormflow components in a small hilly agricultural catchment in east central Pennsylvania. Three events during the autumn recharge

period of 1989 were studied. The first and largest storm was an 80 mm rainfall event with a return period of 5-10 years. During this event, 42 per cent of total flow was derived from shallow subsurface storm flow, 11 per cent from surface event water and 47 per cent from deep subsurface groundwater flow. The major pathways for transferring event water to streams in the 2 principal events were overland flow and channel precipitation. Shallow and deep subsurface pathways were easily distinguished. There are 39 references (see also preceding abstract). U.S.A.

95-1531

**Sankey Brook catchment study**

R. V. MACI WAINF (National Rivers Authority), N. W. J. FLEW and J. N. M. COOPER

*Journal of Institution of Water and Environmental Management* 1994, 8, No 6, 576-584

The hydrological modelling and analysis that had been carried out as part of a major study into the development of Sankey Brook catchment in the Mersey basin are described. A hydraulic model had been constructed and successfully used to simulate the river system and to help in the development and implementation of flood discharge control policies. The flooding problems in the catchment are outlined. The impact of urbanization and of tidal effects are discussed. Data collection, model calibration and the hydraulic characteristics of the more complex systems in the lower reaches of the brook are described. U.K.

95-1532

**Integrated catchment modelling as a water resources management tool**

P. W. RIPPON (Groundwater Development Consultants Ltd, Cambridge) and A. J. WYNNESS

*Journal of Institution of Water and Environmental Management* 1994, 8, No 6, 671-679

The principal features of an integrated catchment management model linking aquifer and river systems are described. The model was based on an integrated finite difference method. Application of the model to several catchments in southern England, in particular the Darent river in Kent, is described. Model preparation and calibration is discussed with reference to the Darent river. Several possible options for restoring flows to the river were then assessed and various management strategy simulations were provided for the river. U.K.

95-1533

**Maximum and mean velocities and entropy in open-channel flow**

C. L. CHU (Pittsburgh University, Pa.) and C. A. A. BIDIN SAID

*Journal of Hydraulic Engineering* 1995, 121, No 1, 26-35

The usefulness of the maximal velocity as a parameter yielding information about open channel flow was examined. Together with the entropy parameter, the maximal velocity could determine the mean velocity in a channel section. In a wide range of discharge and water depth conditions, open channels showed an apparent propensity to establish a state of equilibrium corresponding to a value of the entropy parameter. A technique for determining the discharge from a velocity profile on a single vertical passing through the point of maximal velocity in a channel cross section was developed. This provided an efficient way of estimating discharge in streams and rivers and continuously updating flow resistance during an unsteady flow. U.S.A.

95-1534

**Study of discontinuity of flow in an ephemeral river.**

V. DURAISAMINATHAN (Anna University, Madras), and M. V. SOMASUNDARAM

*Journal of Indian Water Works Association*, 1994, 26, No 3, 151-154

A case study is presented of surface flow analysis of the Palar river, Eastern Karnataka in the upper (Avaramkuppam), middle (Arcot), and lower (Chenglepet) reaches. Data from between 1981 and 1991 were analysed. At Avaramkuppam, flow days through periods of rainfall were even and flow values were moderate. Although rainfall from the south west monsoon predominated, sustainable flow occurred only during the north east monsoon season. At Chenglepet, nearer to the coast, flows depended totally on the rainfall from the north east monsoon. Flow days were less than at Avaramkuppam, although total volume was higher, and was attributable to substantial contribution from the local catchment. At Arcot, flows were less than at Avaramkuppam and Chenglepet, although flash flows occurred which were attributable to local run off. **India**

95-1535

**Effect of bed morphology on flow mixing length at river confluences.**

J. M. GAUDET (Universite de Montreal, P.Q.), and A. G. ROY

*Nature*, 1995, 373, No 6510, 138-139

The effects of bed discordance on flow mixing length were studied for 3 confluences of moderate size. Because of marked differences in ionic content in upstream waters it was possible to use conductivity as an indicator of mixing. Complete mixing was generally observed within 25 channel widths of the confluence though at higher flows there was greater initial divergence from complete mixing compared with low flows. One high flow event was not completely mixed after 40 channel widths. Conductivity data indicated that for low flows, water from the shallower tributary tended to flow over that from the other channel, but at high flows the waters tended to be laterally separated. Vertical separation from the low flow events gave rise to considerable turbulence and rapid mixing but mixing from laterally separated events mixed less rapidly. **Canada**

95-1536

**Use of isotopic data to estimate water residence times of the Finger lakes, New York.**

R. E. MICHELI (U.S. Geological Survey, Reston, Va.), and T. E. KRALMER

*Journal of Hydrology*, 1995, 164, No 1/4, 1-18

A relatively inexpensive method for the estimation of water residence times for groups of lakes where climatic and tritium deposition factors were similar was developed for application to the Finger lakes, a group of 11 lakes in central New York state. A tritium balance model was used to estimate residence times. With 2 exceptions (Seneca lake and Skaneateles lake), results obtained from model simulations were in agreement with earlier estimates based on runoff and chloride balances. Possible reasons for the exceptions related to the sensitivity of the model to parameter changes were investigated. The discrepancy in the case of Seneca lake is explained in terms of groundwater input to the lake. **U.S.A.**

95-1537

**Environmental impact, socioeconomic and safety aspects of Tehri dam project.**

SHRIRAM (M.M.M. Engg. College, Gorakhpur, Uttar Pradesh); *Journal of Indian Water Works Association*, 1994, 26, No 3, 141-149

The Tehri dam project was the first storage scheme in the Ganga valley and would exploit the availability of resources provided by the Bhagirathi river. Environmental impacts of the scheme on inhabitants, reservoir-induced seismicity, soil erosion, sedimentation are considered. Safety records of earth and rockfill dams during earthquakes, defensive design features of the Tehri dam and stability of the reservoir rim are detailed. Remedial measures and socio-economic aspects (compensation and rehabilitation) of displaced urban and rural populations are discussed. Effects of the project on flora, fauna, waterlogging and salinity are briefly considered. **India**

95-1538

**Peak outflow from breached embankment dam.**

D. C. FROHLICH (Kentucky University, Lexington)

*Journal of Water Resources Planning and Management*, 1995, 121, No 1, 90-97

Data concerning 22 embankment dam failures from various published and unpublished sources were used to evaluate and compare several existing empirical equations for the prediction of peak outflow from a breached dam. Multiple regression analysis was then used to develop a new empirical expression for the rapid estimation of peak outflow from a breached embankment dam. The new expression used easily obtained information and provided a method of computing prediction limits from which appropriate factors of safety could be determined for use in evaluating the flood hazard potential of a dam failure where human fatalities were unlikely. There are 50 references. **U.S.A.**

95-1539

**The effects of deep-water siphoning on a small, shallow lake, a long-term case study.**

D. M. LIVINGSTONE (Zurich University), and E. SCHANZ

*Archiv für Hydrobiologie*, 1994, 132, No 1, 15-44

A deep watering siphoning system was installed in the Lutzelsee, Switzerland, in April 1982 to improve water quality. Short term effects of deep water siphoning were monitored from 1981-1984 and long term effects were studied in a monitoring programme for 1977-1992. The study was based on measurements of throughflow, temperature, oxygen concentrations, nutrient concentrations, primary production, chlorophyll-*a*, Secchi depth, and phytoplankton cell densities. Deep water siphoning resulted in higher surface water temperatures in spring and early summer and higher deep water temperatures during summer. Schmidt stability was decreased in late summer and autumn. The siphoning system had no effect on the oxygen conditions in the lake or on total phosphorus in surface waters. Enhanced primary productivity values were observed during the summer following installation of the deep water siphoning system. Apart from this temporary increase the system had no effect on primary productivity. Positive signs indicating a possible long term improvement in the lake trophic status were a reduction in deep water total phosphorus and dissolved phosphorus and an increase in water transparency. There are 55 references. **Germany**

95-1540

**Examples of groundwater modelling in environmental management studies.**

R. P. ASHLEY (Ashley Associates, Cambridge)

*Journal of Institution of Water and Environmental Management* 1994, 8, No 6, 635-645

The development of groundwater modelling techniques from analogue and digital models to present commercial software packages is overviewed. The application of groundwater modelling in evaluating the impact of developments and structures on hydrogeological systems is also examined. Several case studies are presented describing the use of generic groundwater models to development projects. These included the impact of an excavation on groundwater levels in West Bromwich (MODFLOW package) and the impact of a proposed mineral working on stream flows in North Yorkshire (FLOWPATH package). U.K.

95-1541

**Unsteady free flow to an observation well from a semi-confined leaky aquifer.**

O. O. ONYEJE-KWT (National University of Science and Technology, Bulawayo)

*Advances in Engineering Software* 1994, 19, No 3, 173-175

The response of a system involving the unsteady flow of water from a semi-confined leaky aquifer into a borehole was investigated. The non-homogeneous governing equation and the boundary conditions were converted to Sturm-Liouville problems. The closed form solution obtained in this way was important as illustrating the process of groundwater recharge and depletion, and as providing a test procedure for numerical models. That the solution proposed explained observed phenomena. The analysis showed that the influence of the no-flow boundary condition was dominant only above a certain threshold. Zimbabwe

95-1542

**Hydrogeology and hydrogeochemistry of a small, hard-rock island - the heavily stressed aquifer of Jersey**

N. S. ROBINS (British Geological Survey, Wallingford) and P. L. SMIDLEY

*Journal of Hydrology* 1994, 163, No 3/4, 249-269

The groundwater resources of the island of Jersey, the largest of the British Channel Islands group, were studied. The island was formed principally of Precambrian rocks. The fractured basement aquifer provided 30 per cent of the total water needs of the island, together with baseflow to surface catchment storage. Quantitative and qualitative aspects of groundwater resources were assessed in a 3 year field study. The aquifer had an average transmissivity of 3 m<sup>3</sup> per d and an effective saturated thickness of 30-40 m. Deeper groundwater circulation occurred in selected fracture systems. The aquifer was stressed by heavy exploitation and anthropogenic pollution, particularly from agriculture. U.K.

95-1543

**Safe yield of aquifers**

J. C. MILES (Wales University, Cardiff) and P. D. CHAMBERLAIN

*Journal of Water Resources Planning and Management* 1995, 121, No 1, 1-8

Methods of determining the perennial safe yield of groundwater basins are reviewed. A new method of assessing groundwater resources was then derived using a simple one-dimensional flow problem. In its initial form, it was only suitable for situations in which a reasonably steady rate of extraction was envisaged, though the

method was capable of being extended and adapted. The method included approximate representations of basin dimensions, hydraulic characteristics and the estimated duration of the worst drought. A simple graph was used in the application of the method. The applicability of the method was confirmed in a study of the Worton Bunter Sandstones of the English Midlands. U.K.

95-1544

**Borehole flowmeters, field application and data analysis.**

F. J. MOLZ (Auburn University, Ala.), G. K. BOMAN, S. C. YOUNG and W. R. WALDROP

*Journal of Hydrology* 1994, 163, No 3/4, 347-371

The application of electromagnetic flowmeters in boreholes in granular and consolidated media is considered, with particular reference to the Tennessee Valley Authority (TVA) flowmeter. The data obtained in the field were the ambient flow log and the pumping induced flow log. These were then used to calculate other values. Test wells were subjected to periods of development using air lifting to ascertain the effect of formation disturbance on flowmeter readings. Flowmeter data were not highly sensitive to formation disturbance. The use of flowmeters to detect flow from individual fractures or fracture zones in fractured media is also considered. There are 33 references. U.S.A.

95-1545

**Transient water table rise with canal seepage and recharge**

S. RAM (G. B. Pant University of Agriculture and Technology,

Pantnagar), C. S. JAISWAL and H. S. CHAUHAN

*Journal of Hydrology* 1994, 163, No 3/4, 197-202

The problems of water table rise in a finite length phreatic aquifer due to irrigation canal seepage, irrigation return flow and rainfall infiltration was investigated. As an alternative to the use of Laplace transformation to obtain a solution, as in earlier approaches, a simpler approach using an appropriate transformation was adopted. The aquifer was considered to be unconfined, homogeneous and isotropic, overlying an impermeable boundary. The flow system was assumed to be described by the linearized Boussinesq differential equation. The proposed solution was simpler than the existing solution and gave results close to those of the existing solution for the numerical example used. India

95-1546

**Injection of industrial wastewater in Israel, siting criteria for deep injection wells and associated problems.**

R. NATH (Jerusalem Hebrew University, Rehovot), I. HEMO

and G. WEINBERGER

*Journal of Hydrology* 1994, 163, No 3/4, 299-323

Regions and subsurface intervals in Israel suitable for wastewater injection were investigated. Existing geological, geophysical, hydrological and water quality data were used to determine the reservoir and confining potential of the rocks. The quality of the existing data drawn from deep oil and gas test drilling, was evaluated in relation to the specific purpose of the study. Desired qualities of subsurface reservoirs for wastewater injection were defined. A screening procedure for potential reservoirs is proposed. Procedures for assessing data on rock permeability, water pressure, salinity and temperature from deep test wells in relation to wastewater injection are suggested for 2 reservoirs in west central and northern Israel. Israel

95-1547

**Regional recharge to a karst aquifer estimated from isotopic composition of diffuse and localized flow South Australia.**

P. W. LEANEY (Centre for Groundwater Studies, Glen Osmond S.A.) and A. L. HERCZEG

*Journal of Hydrology*, 1995, **164**, No 1/4, 363-387

A limestone karstic aquifer overlain by soil of variable permeability in a sub-humid to semi-arid region of South Australia was studied with respect to the relative importance of different recharge mechanisms. The chemical and isotopic signature of regional groundwater from shallow boreholes in the area and water from sinkholes, swamps, drains and soil in the unsaturated zone was measured and a regional estimate for recharge developed for different land elements. Recharge was low for about half of the study area which had predominantly clay soils. For the remainder, recharge had increased significantly since agricultural development. Irrigated areas had contributed markedly to groundwater salinity over the preceding 30 years. **Australia**

95-1548

**High-rate bioremediation of chlorophenol-contaminated groundwater at low temperatures**

K. T. JÄRVINEN (Tampere University of Technology), E. S. MELIN and J. A. PUHAKKA

*Environmental Science & Technology*, 1994, **28**, No 13, 2387-2392

Aerobic fluidized bed treatment was used for psychrotrophic bioremediation of chlorophenol-contaminated groundwater from Karkola, Finland. Four laboratory-scale continuous flow reactors were inoculated with non-acclimated activated sludge and operated at 14-17°C. The fluidized bed volume was 460 ml. After start-up the treatment temperature was decreased to 4°C. At 5-7°C more than 99.9 per cent chlorophenol biodegradation was achieved at a chlorophenol loading rate of 740 mg per litre d. Effluent with less than 0.003 mg chlorophenol per litre was achieved, which was close to drinking water quality. High-rate chlorophenol mineralization was demonstrated by close to stoichiometric inorganic chloride releases and organic carbon removals. **Finland**

95-1549

**Groundwater protection zones. An inter-Provincial view**

E. J. de LUGENHORST (Overijssel afdeling Milieu) and M. WEISZ

*H2O*, 1994, **27**, No 26, 782-784 (in Dutch, English summary, p. 761)

The views of the Dutch provinces on the extension of groundwater protection zones are summarized. The response considered desirability, practicability, and costs. On desirability, much would depend on what progress was made or required towards the attainment of standards for water quality by a prescribed date, particularly in terms of nitrate removal. Here, a model study of the groundwater quality anticipated at a specific location should be used, before an extension of its protection zone was sought or decided upon. On practicability and costs, these were regarded as likely to be feasible and acceptable, depending ultimately on the extent of additional protection required, and the amount of land it would need. Farmers would need to be compensated for any loss of cultivable land, but provided the financial arrangements which had made the present protection system acceptable to them could be extended proportionately, the Government's suggestion was welcomed. (English translation 180 pounds sterling, valid for 1995). **Netherlands**

95-1550

**Bioremediation of chromate-contaminated groundwater by reduction and precipitation in surface soils.**

M. E. LOSI (California University, Riverside), C. AMRHEIN, and W. T. FRANKENBERGER

*Journal of Environmental Quality*, 1994, **23**, No 6, 1141-1150

The ability of soil to remove chromate from contaminated water was investigated by a glasshouse experiment in which samples of mixed thermic Typic Torripsamments soil were amended with 0, 12 and 50 Mg dried cattle manure per ha, planted with alfalfa (*Medicago sativa*) and irrigated under 4 different schemes for 20 weeks with water containing 1000 µg chromium(VI) per litre. Analysis of weekly samples of drainage water showed that chromium removal rates ranged from 51 per cent in unamended soil to up to 98 per cent in organic matter (OM)-amended soil. High-frequency (daily) irrigation increased the residence time of water in the bioreactive zone resulting in higher rates of chromium reduction/immobilization than weekly irrigation. Chromium removal increased with OM loading and the leachate chromium concentration was consistently below 50 µg per litre in the 50 Mg OM per ha treatments. The presence of alfalfa plants appeared to inhibit chromium reduction in OM-amended soils and alfalfa shoots took up less than 0.5 per cent of total added chromium. The proposed method could provide a cost-effective treatment for chromium-contaminated groundwater and longer term field studies are recommended. **U.S.A.**

95-1551

**Balancing safety and the environment.**

D. MFRICAS (ITT Immo Tech Inc., Ann Arbor, Mich.) and B. WAGONER

*Water Environment & Technology*, 1994, **6**, No 12, 38-43

A conflict of interest between human safety and the maintenance of environmental quality is illustrated for the case of aircraft de-icing fluids, needed to ensure the safety of flights but detrimental to water quality. The procedures and materials used for de-icing and anti-icing for both aircraft and runways are outlined. Only fluids based on ethylene or propylene glycol are at present authorized, though alternatives show promise. Proper disposal of chemicals is important, as the BOD of the volume of fluid used on a large passenger plane (approximately 1000 gallons) was equivalent to that generated by about 5000 people. Methods adopted at various North American airports are surveyed, most depended on efficient collection of the products, either by isolating them or by conducting them to containers before collection and treatment off site; the latter practice is applicable only when de-icing is conducted in dedicated bays. Drainage from runways was subject to similar alternatives. Arrangements that might obviate the need for chemicals include the parking of aircraft in hangars rather than in the open, passing hot air or water over their surfaces, and sweeping off snow. **U.S.A.**

95-1552

**Activated biofilm removal of low concentrations of toluene.**

R. D. NEUFELD (Pittsburgh University, Pa.), S. NIAKI, C. BADALI, P. K. T. LIU and D. POWERS

*Water Environment Research*, 1994, **66**, No 7, 899-904

A 2-step technique for the biodegradation or biotransformation of low concentrations of benzene, ethylbenzene, toluene, and xylene (BTEX) hydrocarbons is described. Data was presented for toluene degradation. Step 1 incorporates the batch growth and attachment of a biofilm onto plastic surfaces using a pre-selected substrate which can stimulate biological activity. Step 2 involves continuous upflow biodegradation of low concentrations of target organics by the

biofilm. The biokinetic rate of compound transformation was a function of the dosage of initial selector compound. Minimal total organic carbon removals took place across the biotowers when operated in Step 2, suggesting that target compounds were degraded partially into alternative substances or metabolic byproducts. U.S.A.

95-1553

**Drinking and industrial water supply from Sardar Sarovar project in Gujarat.**

C. C. PATEL (Sardar Sarovar Narmada Nigam, Gandhinagar) and M. U. PUROHIT

*Journal of Indian Water Works Association*, 1994, 26, No 2, 117-121

The water scenario in Gujarat is outlined and plans for solving the water shortage using the Narmada canals are discussed. The principles agreed by the Industries Department for planning and allocation of water for industrial use are listed and their economic viability given. India

95-1554

**Water resources development in India - an overview**

S. C. SUD (Ministry of Water Resources, New Delhi) and M. SIVADAS

*Journal of Indian Water Works Association*, 1994, 26, No 3, 135-139

The availability of surface and groundwater resources in India is briefly reviewed. Present and future water use is considered. Constraints on water resource development, the National Water Policy and the national perspective plan are discussed. Measures to conserve water are identified including control of evaporation losses, run water harvesting and conservation in irrigated agriculture. Environmental concerns are briefly considered. India

95-1555

**A fuzzy linear programming model for water resources allocation**

S. MOHAN (Indian Institute of Technology, Madras)

*Journal of Indian Water Works Association*, 1994, 26, No 3, 155-158

The concept of fuzzy set theory and its application to water resource allocation is discussed. One possible way of identifying membership functions is presented. India

95-1556

**Water resources for Rajkot Urban Development Authority, Rajkot (Gujarat State)**

V. R. PATIL (Rajkot Urban Development Authority, Gujarat)

*Journal of Indian Water Works Association*, 1994, 26, No 3, 178-180

Water supply development for Rajkot is briefly considered. Supply forecasts up to the year 2013 are identified and long term planning to meet future demand is briefly discussed. India

95-1557

**Yield model for screening surface- and ground-water development.**

L. LALL (Utah State University, Logan)

*Journal of Water Resources Planning and Management*, 1995, 121, No 1, 9-22

A method of optimizing the choice of water resources development projects as between candidate surface-water reservoirs and ground

water developments is proposed. The method incorporated a yield model which could be used to carry out a preliminary screening of alternative projects and to identify storage capacities and pumping yields. A hybrid simulation-optimization strategy was used to assess monthly operation of proposed systems using historical or synthetic hydrological data. Reservoir sizing was handled using a modified sequent peak algorithm, while a unit response matrix approach was used to model the groundwater subsystem. The procedure was applied to the Jordan river basin in Utah, U.S.A.

95-1558

**Optimization of transfers in urban water supply planning**

J. R. LUND (California University, Davis) and M. ISRAFI

*Journal of Water Resources Planning and Management*, 1995, 121, No 1, 41-48

Two stage and multi stage linear mathematical programming was used to plan water transfers, as part of a multi source urban water supply system. The programs concerned were formulated and applied to an illustrative example to show how several forms of transfer could be integrated with drought water conservation and conventional water supplies to meet anticipated system demands. Water marketing opportunities, such as dry year options and spot market water transfers, were integrated with conservation measures and traditional supplies. Limitations of simple mathematical programming techniques in relation to water transfers were also examined. U.S.A.

95-1559

**Resourcefulness in the search for a new source**

*Water Services*, 1994, 98, No 1187, 30-31

Wessex Water was investigating a new water source in south east Dorset to reduce or replace present water abstraction from the Brianspuddle source. This involved drilling boreholes up to 300 m deep to pass through the tertiary clays and sands into the underlying chalk and intercepting the water before it flowed into the sea in Poole bay. Parameters being monitored by telemetry at the boreholes included groundwater levels, temperature, conductivity, barometric pressure and flow rate. Features and operation of the telemetry system are outlined. The approach being adopted to balance future demands for water with minimizing impacts on the local environment is discussed. U.K.

95-1560

**Matching of water supply with growing demands**

C. D. THATTI

*Journal of Indian Water Works Association*, 1994, 26, No 2, 67-71

Topics discussed in this lecture, delivered at the 26th Annual Convention of the Indian Water Works Association, include the availability of surface and groundwater, dependability for planning, basin wide availability, surface reservoirs, minor and micro level harvesting, groundwater development, trans basin transfers, water disputes and allocations, non consumptive uses, recycling and waste in irrigation uses. A diagram of the possible scenario of water availability and uses in 2025 AD, and basin wide surface and groundwater resources of India are given. India

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95-1561

**Water resource assessment of Jaipur - an integrated scenario**  
N. C. RAJIVANSHI and A. BHARGAVA

*Journal of Indian Water Works Association* 1994, 26, No 2, 99-101

The historical background and present status of the water supply in Jaipur is outlined. The water demand in the agricultural, municipal and industrial sectors are given and the additional requirements up to the year 2031 are estimated. **India**

95-1562

**Hope out of Africa**

D. SPARK

*Water & Environment International* 1994, 3, No 3, 1-5

Despite being the driest country in southern Africa, 60 per cent of the homes in Namibia's populous north had safe tap water and the water demand of the fast growing capital, Windhoek, was being met. However, the water was expensive to supply and it was important to manage water demand. Water resources included dam systems and traditional measures, such as shallow wells. Desalination might be used to supply coastal towns. **Namibia**

95-1563

**Impact of treated oil refinery effluent on crop productivity and agricultural soils**

G. AZIZ (Aligarh Muslim University), A. INAM and R. H. SIDDIQI

*Indian Journal of Environmental Health* 1994, 36, No 2, 91-98

The treated effluent of Mathura oil refinery was used as an irrigant by local farmers. The effluent was characterized and in field experiments, its effects on soil physico-chemical characteristics and on the growth and yield of triticale and wheat were studied. The treated effluent was superior to groundwater for growth and yield of both crops. Additional quantities of nutrients were present in the effluent. The treated oil refinery effluent met the normal quality criteria for irrigation water. **India**

95-1564

**Planning and development of water sources and constitution of river authorities**

S. PRAKASH

*Journal of Indian Water Works Association* 1994, 26, No 2, 63-65

This presidential address delivered at the 26th annual convention of the Indian Water Works Association on 16th February 1994 at New Delhi discusses the need and importance of conservation of water, aspects of quality and water reuse, auditing the water industry by identifying areas for energy saving and maintaining optimal levels of efficiency, the requirement of funds and privatization of the water industry. **India**

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See also Abstracts 95-1509, 95-1539, 95-1542, 95-1546, 95-1547, 95-1675, 95-1688, 95-1717, 95-1751, 95-1975

95-1565

**Computation of concentration distribution in natural streams.**  
A. C. DEMETRIACIOPOULOS (Patras University)

*Advances in Engineering Software* 1994, 19, No 3, 161-172

The computation of concentration distributions in streams is considered. A unified approach to the computational problem was developed. An equation describing mass transport in a stream of variable width was obtained from the equation in terms of Cartesian coordinates describing mass transport in a stream of constant width using transformed coordinates. The solution domain for these was rectangular. A common numerical discretization procedure was suitable for both equations. This was based on the use of the control volume approach and the power law interpolation scheme between nodes. The transverse mixing coefficient was computed for a river reach. **Greece**

95-1566

**Planning and implementation of a comprehensive ecological risk assessment at the Milltown Reservoir-Clark Fork River Superfund Site, Montana**

G. A. PASCOE (Environmental Toxicology International Inc, Seattle, Wash.) and J. A. DALSGAARD

*Environmental Toxicology and Chemistry* 1994, 13, No 12, 1943-1956

The Milltown Reservoir-Clark Fork River Sediments Superfund Site is a National Priority List (NPL) site in Montana, U.S.A. A baseline risk assessment programme was initiated in 1989 by the U.S. EPA at the site to identify chronic risks to ecological receptors from metal contaminated sediments that had deposited in aquatic and terrestrial habitats at the site. The site history and sources of contamination, conceptual framework of the ecological assessment, and problem formulation are reviewed. The problem formulation summarized the nature of contamination at the site, identified ecological concerns, potential pathways and receptors of exposure, outlined an approach and developed a study plan for the assessment. There are 71 references. **U.S.A.**

95-1567

**Assessing risk of ground-water pollution from land-disposed wastes**

K. UNLU (Middle East Technical University, Ankara)

*Journal of Environmental Engineering* 1994, 120, No 6, 1578-1597

A stochastic screening model was developed to evaluate uncertainties in contaminant concentrations due to uncertainties in waste composition and hydrogeological properties of waste sites and to assess the expected magnitude of contamination at receptor points downgradient from a waste pit. The model determined the exceedance probabilities of a specified concentration level at receptor points using Monte Carlo (MC), first order (FO) and point estimate (PE) methods. Two source submodels (for salts and oily wastes), the unsaturated zone transport submodel and the saturated zone submodel are described. A comparison of the error analysis methods was performed. This indicated that for conservative contaminants the FO method was comparable with the accuracy of the MC method.

The performance of the FO and PE methods were very sensitive to the fate and transport behaviour of contaminants and these methods were less accurate than the MC method for nonconservative contaminants. There are 32 references. Turkey

95-1568

#### Discrete simulation approach for network-water-quality models

P. F. BOULOS (Montgomery Watson, Pasadena, Calif.), I. ALTUMAN, P. A. JARRIGE, and F. COLLEVAIT  
*Journal of Water Resources Planning and Management*, 1995, 121, No 1, 49-60

Algorithms for solving the contaminant transport problem in water distribution systems and their limitations are briefly considered. The Event Driven Method of Boulos was extended to handle time varying hydraulic conditions. The resulting method could be effectively used to model chemical, biological and hydraulic changes resulting from distribution system activities and to predict the spatial and temporal distribution of constituents throughout the piping system. A 1-dimensional transport model was assumed, with instantaneous and complete cross sectional mixing of material. Longitudinal dispersion was neglected. The method was applied to an example network. There are 30 references. U.S.A.

95-1569

#### Mosquito manages pollution problems

N. SCARLETT (Integrated Hydro Systems)  
*Water & Waste Treatment*, 1994, 37, No 12, 24

Yorkshire Water Services were evaluating the effects of the Hull sewerage system on the Humber estuary using a Mosquito model to simulate the actual quantity and quality of flows in the drainage system. Mosquito, a sophisticated urban pollution management tool, was based on WALLERUS and was a prototype for QSIM, a water quality module. Mosquito was designed to model stormwater quality, investigating all factors on the same system. The procedures, sampling programme, laboratory analysis and sampling instrumentation used for the Hull study are described. U.K.

95-1570

#### Restoration of a channelized reach of the river Gelsa, Denmark: effects on the macroinvertebrate community

N. FRIBERG (National Environmental Research Institute, Silkeborg), B. KRONVANG, L. M. SVENDSEN, H. O. HANSEN, and K. B. NIELSEN  
*Aquatic Conservation*, 1994, 4, No 4, 289-296

The macroinvertebrate community's density and diversity were surveyed before and after the restoration of a reach of the Gelsa river from a 1.7 km channel to a 1.9 km meandering course. The results were compared with those obtained from an unrestored upstream channelized reach. Two years after restoration, density and diversity were greater than in the control reach. *Gammarus pulex* was abundant. Species preferring a stony habitat favoured the new reach, with *Heptagenia sulphurea* Mull. only found there. Two other stone preferring species were present in higher density in the control reach but this was probably because of competition for the limited space on the stones. The study demonstrated the positive impact of river restoration on macroinvertebrate community structure. This probably benefited higher trophic levels as the number of prey increased. Denmark

95-1571

#### Relationships between littoral microcrustacea and aquatic macrophyte communities on the Isle of Skye (Scotland), with implications for the conservation of standing waters.

C. A. DUKIGAN (Countryside Council for Wales, Bangor) and W. L. KOVACH

*Aquatic Conservation*, 1994, 4, No 4, 307-331

Data were obtained on aquatic macrophytes, water chemistry and microcrustacea, represented by Ctenopoda, Anomopoda and Onychopoda, from 51 freshwater lochs during the summer of 1989. The lochs were placed into 1 of 10 classes defined by a TWINSPLAN analysis of the records of submerged and floating plant species. Correlations between this classification, environmental data and the microcrustacean assemblages were investigated by canonical correspondence analysis. Lochs were also classified according to the assemblages by cluster analysis. The major trends in microcrustacean distribution were related to pH, catchment area, macrophyte density and the distance from the sea. There was little correlation between the plant community types and microcrustacean assemblages. There are 66 references. U.K.

95-1572

#### Ecological assessment for the wetlands at Milltown reservoir, Missoula, Montana: characterization of emergent and upland habitats

G. LINDER (U.S. Fish and Wildlife Service, Helena, Mont.), R. HAZELWOOD, D. PALAWSKI, M. BOLTMAN, D. WILBORN, J. MALLOY, K. DUBOIS, S. OIT, G. PASCOE and J. A. DALSGAARD

*Environmental Toxicology and Chemistry*, 1994, 13, No 12, 1957-1970

As part of a baseline risk assessment programme initiated in 1989 by the U.S. EPA at the Milltown reservoir Superfund site in Montana, U.S.A., a soil contamination evaluation and ecological assessment were conducted. Soil physico-chemical characteristics, results of earthworm toxicity tests, root elongation and groundwater phyto-toxicity assessments, root elongation tests on soil eluates, preliminary studies using amphibian and bacterial test systems, and metals accumulation in upland and terrestrial plants are described. The results of these evaluations yielded an integrated evaluation of the ecological effects of contamination at the site. No acute toxicity or adverse biological effects were occurring at the site. There are 39 references. U.S.A.

95-1573

#### Hydraulic parameters and benthic invertebrate distributions in two gravel-bed New Zealand rivers

J. M. QUINN (National Institute of Water and Atmospheric Research, Hamilton) and C. W. HICKLEY  
*Freshwater Biology*, 1994, 32, No 3, 489-500

Samples taken from 2 rivers that differed in substrate size variability showed that benthic invertebrate variability had similar correlations with mean velocity (10-150 cm per second) and the complex near-bed hydraulic variables (Froude number, shear velocity, water column and boundary Reynolds number) in the river with uniform cobble substrates. In the river with diverse substrates, average correlations with Froude number, inferred shear velocity and boundary Reynolds number were 25-45 per cent higher than with velocity. Although the boundary Reynolds number, calculated from simple measures, was most strongly correlated with benthic invertebrate distributions and taxa richness, distributions were more strongly correlated with predictions of multiple regression models incorpo-



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rating substrate size, depth and mean velocity than with any single hydraulic variable. Depth might have an important non-hydraulic influence on collector browsers and might also affect local variations in disturbance patterns. There are 38 references. **New Zealand**

95-1574

### **Invertebrate communities and turnover in wetland ponds affected by drought**

M. JEFFRIES (Northumbria University, Newcastle upon Tyne)  
*Freshwater Biology*, 1994, 32, No 3, 603-612

A study of small ponds on a freshwater marsh in 1986-1987 and 1992, showed that permanent ponds accumulated taxa over the study period. Ponds that were wet throughout 1986-87 but dried in 1992 after the drought lost some of the taxa associated with permanent water but acquired a reduced fauna typical of temporary ponds. Ponds that were temporary in 1986-87 were dry during most of 1992 and lost almost all aquatic taxa. Extinction rates were high for taxa typical of permanent or temporary ponds, while colonization rates were poor for taxa from permanent water but high for taxa from temporary ponds. Metapopulation incidence functions gave reasonable predictions of observed colonization but were poor predictors of extinction. **UK**

95-1575

### **Classification and inventory of wetlands in the southern Appalachian region**

J. M. HEINER (U.S. Department of the Interior, Atlanta, Ga.)  
and C. G. STORRS

*Water, Air, & Soil Pollution*, 1994, 77, No 3/4, 209-216

The wetland maps of the southern Appalachian region, prepared by the National Wetlands Inventory of the U.S. Fish and Wildlife Service, are described. They record the life form of the dominant vegetation, substrata where vegetation was sparse or lacking, water chemistry, duration of inundation or saturation, and special modifiers. Areas as small as 0.5 ha and as narrow as 8 m could be identified. The maps were produced through remote sensing by high altitude colour-infrared aerial photography supported by ground-based data. Limitations arose from the quality of the aerial photography, the training of photographic interpreters, and the wetland types to be classified. **U.S.A.**

95-1576

### **Identification of wetlands in the southern Appalachian region and the certification of wetland delineators**

J. S. WAKELLEY (U.S. Army Engineers, Vicksburg, Miss.)

*Water, Air, & Soil Pollution*, 1994, 77, No 3/4, 217-226

Aspects of the southern Appalachian region made the field indicators of wetland identification, namely hydrophytic vegetation, hydric soils and wetland hydrology, difficult to interpret. Problems included wetlands developed on recently deposited alluvial soils showed little evidence of hydric conditions, areas occupied by facultative dominated communities, wetlands affected by drainage schemes, man-induced wetlands, and hydric soil units too small to be separately delineated on soil survey maps. A Wetland Delineator Certification Programme was initiated in 1990 to improve delineation and reduce verification time. A 1 year demonstration had recently been completed and nationwide implementation was planned for 1994. **U.S.A.**

95-1577

### **Plant community distribution and water chemistry of fen peatlands in West Virginia's Appalachian plateau**

M. R. WALBRIDGE (George Mason University, Fairfax, Va.)

*Water, Air, & Soil Pollution*, 1994, 77, No 3/4, 247-269

Vegetation in 4 fen wetlands in the Appalachian plateau, W. Va., was delineated by aerial photography and field surveys based on infrared colour, texture and vegetation height. Data were acquired on soil saturation, landscape position, disturbance history and surface water chemistry. Environmental variables affecting plant community distribution were sought by several statistical techniques including agglomerative cluster analysis, principal component analysis, correlation matrix, and analysis of variance. Thirty-four communities were identified which represented forest, tall shrub, low shrub, herbaceous and bryophyte communities. Only 34 of the 138 species were common to all sites. Forest and tall shrub communities were favoured by water of pH 4.6-5.0 dominated by base cations, while pH of 4.0-4.4 suited low shrub and bryophyte communities. Much variation arose from changes in soil saturation affecting the distribution of *Hypericum densiflorum*, *Rubus hispida*, *Polystichum commune* and *Sphagnum fallax*. Beaver disturbance also influenced community distributions. **U.S.A.**

95-1578

### **Hydrologic and wetland characteristics of a Piedmont bottom in South Carolina**

D. D. HOOK (Clemson University, S.C.), W. H. MCKEE, J. M. WILLIAMS, S. JONES, D. van BLARICOM, and J. PARSONS

*Water, Air, & Soil Pollution*, 1994, 77, No 3/4, 293-320

Wetland traits were studied for 2 years on a 4 ha mixed bottomland hardwood site with freely draining soils. Flooding occurred on average 4.4 times per year and 1.5 times during the growing season over a 13 year period. The portion meeting federal wetland criteria was defined by a hydrological model, soils, water table levels, and geographical information system techniques. Less than 1 ha met these criteria. The wetland status of the vegetation within the bottom and adjacent slope did not correlate with water table levels, predicted wetland areas or landforms. Wetland characteristics were closely related to hydric soil traits in the upper 25 cm of the Chewach and Chenneby soil types. These wetlands primarily resulted from local precipitation rather than flooding. The site was an excellent habitat for song birds and small mammals, and provided a travel corridor with adjacent forest stands. **U.S.A.**

95-1579

### **Landscape-level processes and wetland conservation in the southern Appalachian mountains**

S. M. PEARSON (Oak Ridge National Laboratory, Tenn.)

*Water, Air, & Soil Pollution*, 1994, 77, No 3/4, 321-332

The physical and biotic linkages of wetlands with the surrounding landscape are discussed. Climate change, land use, land cover change, water and air borne pollution, a shift in disturbance/recovery regimes, habitat loss and fragmentation all affected wetlands. Climate and land cover changes influenced landscape hydrology and water balances of wetlands. Excessive nutrients and toxic substances disrupted natural patterns of nutrient cycling. Periodic disturbances such as flooding often maintained wetlands, while others such as fires influenced species composition. Many plant and animal species in wetlands depended on complementary habitats in the surrounding landscape; without them, many populations would collapse. There are 31 references. **U.S.A.**

95-1580

**Non-alluvial wetlands of the Southern Blue Ridge - diversity in a threatened ecosystem.**

A. S. WEAKLEY (North Carolina Natural Heritage Program Raleigh), and M. P. SCHAFALÉ

*Water, Air, & Soil Pollution* 1994, 77, No 3/4, 359-383

The relatively rare and invariably small wetlands of the Southern Blue Ridge are described and their vegetation discussed. Despite their low number they were important habitats for rare plants and animals. Species composition was related primarily to elevation, topographic position, hydrology, underlying bedrock composition, recent land use and biogeographical history. Nine groups of non-alluvial wetlands were recognized. Much destruction had occurred reducing their area from 2000 to 300 ha; most of the remnants were compromised by hydrological alteration and nutrient inputs. Long-term viability was made difficult by their location on privately owned land. There are 50 references. U.S.A.

95-1581

**Reservoir riparian zone characteristics in the upper Tennessee river valley**

C. C. AMUNDSEN (Tennessee University, Knoxville)

*Water, Air, & Soil Pollution* 1994, 77, No 3/4, 469-493

The characteristics of the summer riparian forests of the Watts Bar (WB) dam, one of the Tennessee Valley Authority reservoirs, were studied in the field and from previously gathered data. Transects were made in the forest after considering species composition and the level of contemporary disturbance. Regional bottomland forests were compared; coefficients of species similarity showed 70 per cent compositional similarity but basal area densities were dissimilar. Overall, WB stands and regional comparisons averaged 19.6 and 30.0 m<sup>2</sup> per ha, respectively. Winter drawdown for flood alleviation allowed distinct herbaceous and graminoid communities to develop on the mudflats over 5-6 months. The mesic forest had been displaced upslope by hydric habitat conditions. Erosion had reduced the summer riparian habitat and increased the mudflats. The extant riparian zone was valuable for minimizing erosion and providing habitats. There are 34 references. U.S.A.

95-1582

**Zooplankton community structure of Cuvuscu and Eber lakes in Central Anatolia**

N. EMIR (Hacettepe University, Beştepe, Ankara)

*Acta Hydrochimica et Hydrobiologica* 1994, 22, No 6, 280-288 (in English)

Detailed zooplankton studies were performed on Eber and Cuvuscu lakes in Asia Minor to determine the seasonal variation in species composition for rotifers and crustaceans. The investigations were carried out over a period of 3 years using a zooplankton net with a 44 µm mesh. A greater species diversity was observed for Cuvuscu lake, an oligo-mesotrophic lake of 1000 ha extent with a maximal depth of 4 m, than for Eber lake, a shallow eutrophic water body ranging from 5200-17 000 ha in extent with a maximal depth of 2.5 m. The species observed are classified and included 13 rotifer species not previously recorded in Turkey. Turkey.

95-1583

**Seasonal variation in composition and production of planktonic communities in the lower river Rhine.**

W. ADMIRAL (National Institute of Public Health and

Environmental Protection (RIVM), Bilthoven), L. BREEBAART

G. M. J. TUBBING, B. van ZANTEN, E. D. de RUIJTER van

STEVENING, and R. BLIJERK

*Freshwater Biology* 1994, 32, No 3, 519-531

Samples taken at 2 stations on the Rhine river, one in the mouth at 1019 km and one at the German/Dutch border at 863 km showed high densities of phytoplankton and occasional depletion of dissolved silica at the upstream station. Phytoplankton blooms dominated by a few species of centric diatoms declined one order of magnitude during down stream transport. In non bloom condition algal densities were maintained or increased slightly. There was a broad summer maximum of bacterial cell number and production with activity peaks of 0.5 nM thymidine per h coincident with phytoplankton blooms. Bacterial production in winter was between 0.02-0.05 nM per h. Rotifers and crustaceans made up the greater part of the zooplankton biovolume, but in the upstream site the contribution of *Dreissena* larvae and rhizopods was also substantial. Algal density appeared to control grazer density rather than the reverse. There are 38 references. Netherlands.

95-1584

**Temporal variations in the concentration and character of dissolved organic matter in a highly coloured stream in the coastal zone of northern Sweden.**

H. IVARSSON (Umeå University), and M. JANSSON

*Archiv für Hydrobiologie* 1994, 132, No 1, 45-55

Temporal variations in dissolved organic matter (DOM) in a highly coloured second order stream in northern Sweden, the Lillån river, were monitored during August 1990 to August 1992. Total organic carbon (TOC), charge density of the TOC, and C/N ratio were used to quantify and characterize the DOM. The mean annual transport of TOC was 6100 kg per km<sup>2</sup>. The spring floods accounted for 33 per cent and the autumn period for 42 per cent of this transport. The lowest TOC concentrations occurred during low flow in winter and summer. Absorbance was strongly correlated with TOC. TOC was also correlated with the concentrations of dissociated organic anions. The charge density of the TOC was 5.9-13.1 µeq per mg TOC. There was no correlation between charge density and discharge over the year. There was a weak correlation between TOC and C/N ratio. No apparent correlation was observed between TOC and the proportion of hydrophobic and hydrophilic fractions. The streamwater DOM had different origins and characteristics during high and low flow periods and in different seasons. There are 33 references. Sweden.

95-1585

**Ammonium ion and organic phosphorus as major in-situ contributors to dissolved fluorescence of the near northwestern Bay of Bengal.**

N. S. SARMA (Andhra University, Visakhapatnam), I. N. RAO and K. ANNAPURNA

*Marine Chemistry* 1994, 47, No 3/4, 255-267

The distribution of dissolved fluorescence and the contribution to it of some important inorganic and organic species was investigated in the coastal waters of the Bengal bay. The major inputs for the DFI identified were the humus rich influx from land at the surface and the solubilized fluorescent matter from resuspended bottom particles. Photodegradation of DFI occurred at the surface during sunny days and was high around noon at low salinities. At the surface

## WATER QUALITY

fluorescent metabolites of ammonium and dissolved organic phosphorus (DOP) were released with dissolved carbohydrate (DCHO) during photosynthesis which was related to the availability of nitrate, silicate and orthophosphate. At lower levels of DFI ammonium was the most important factor affecting DFI in the water column while at higher levels DOP was important. The ratio of the relative efficiencies of DOP and ammonium changed from 1.4 at the surface to 3.4 at depth. Steric factors (chelation and molecular rigidity) might cause the DOP of deep water to be a more efficient source of DFI. There are 41 references. **India**

95-1586

### **Hydrochemistry of the Bay of Bengal: possible reasons for a different water-column cycling of carbon and nitrogen from the Arabian sea.**

C. K. RAO (National Institute of Oceanography, Goa), S. W. A. NAQVI, M. D. KUMAR, S. J. D. VARAPRASAD, D. A. JAYAKUMAR, M. D. GEORGE and S. Y. S. SINGHAI  
*Marine Chemistry*, 1994, 47, No. 3/4, 279-290

In a study of the western Bengal bay during the pre south west monsoon and north east monsoon of 1991, the relationships of the nitrate and the phosphate tracers  $\text{NO}_3^-$  and  $\text{PO}_4^{3-}$  to potential temperatures were used to identify 3 end member water masses. These were the low salinity surface water, the high salinity intermediate water advecting from the Arabian sea and the deep water of circumpolar origin. The 12 degree discontinuity defined the boundary between these zones. The smaller thickness of the oxygen minimum layer in the bay was attributed to the shallower location of the discontinuity. There were marked seasonal changes in intermediate waters. Comparisons are made between the  $\text{NO}_3^-$  potential temperature relationships of the Arabian sea and Bengal bay and the possible reason for differences in redox conditions at mid depths in these waters are discussed. There are 42 references. **India**

95-1587\*

### **The rational for demanding nutrient removal from wastewater - the Danish experience**

P. HARRIMOES (Denmark Technical University, Lyngby)  
*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.  
The problems of eutrophication of marine waters in the area between Denmark and Sweden, especially the Kattegat, which were recognized in the early 1970s as possibly associated with nutrient discharges, are reviewed. The occurrence of severe oxygen depletion in these waters on a number of occasions prompted much investigation of possible causes and their solution. To arrive at a balanced conclusion as a basis for further action, a consensus conference was held in 1986, as a result of which certain findings were published in 1987. The subsequent political decisions are outlined, followed by an outline of the situation discussed at the second consensus conference in 1991, at the half way stage of the programme for nutrient removal from both point and non-point sources. The results achieved since then as part of the commitment of the Danish authorities to eliminate nutrients from all wastewater discharges within 5 years are summarized, indicating that in respect of point source discharges the programme had been very successful in curtailing nutrient emissions, although the situation for non-point sources (agricultural runoff) was far from satisfactory. **Denmark**

95-1588\*

### **The link between effluent standards and receiving water guideline.**

P. C. LLEN (Canberra University, Belconnen, A.C.T.)  
*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.  
The problem of determining acceptable limits for the discharge of effluents containing nutrients, especially phosphorus, into natural waters is reviewed against a background of conditions obtaining in Australia, where streamflow can vary widely. The earlier approaches developed in connection with the removal of organic matter were phrased in terms of the concentration of a particular parameter in the effluent. This assumed the existence of a mixing zone in which the concentration in the water body gradually approaches the final average concentration determined from the dilution factor. The difficulty of defining the extent of the mixing zone and the wide variability in the dilution factor for Australian rivers, are cited as reasons why an alternative approach, based on loading rates and total pollutant loading over a particular time interval should be considered. The application of this method in the case of phosphorus is discussed. While a simple mass balance approach is adequate under constant conditions, the uptake of phosphorus by the biota and periodic release from sediments displaced during flood flows present quite serious difficulties. **Australia**

95-1589\*

### **Prevention of the eutrophication of the Great Lakes.**

J. R. VALLentyne (Canada Centre for Inland Waters, Burlington, Ont.)  
*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.  
A historical review of the background to and implementation of a pollution abatement programme for the Great Lakes, North America, is presented. The growing awareness of the problems of nutrient pollution during the 1960s, the publication of the Vollenweider model in 1968 for predicting the trophic status of water bodies with reference to the areal phosphorus loading rates, and deteriorating water quality and ecosystem balances in Erie and Ontario lakes, are described. Following the signing of the Great Lakes Water Quality Agreement in 1972, a 3 approach to the reduction of phosphorus discharges was adopted, comprising drastic reductions in the amount of phosphates in detergents, introduction of phosphorus removal measures in sewage treatment plants and limitation of nutrient inputs from agricultural sources. The effectiveness of these measures was reflected in a levelling-off by 1974-1976 of the spring peak for total phosphorus concentration in Ontario lake at 22-23 mg per  $\text{m}^3$ , followed by a gradual decline over the next 10 years to 9-11 mg per  $\text{m}^3$ , exactly the level predicted by the application of the Vollenweider model. Phytoplankton and chlorophyll levels also declined, although to a lesser degree, possibly due to changes in foodweb dynamics, while mid-lake levels of soluble reactive phosphorus fell to less than 1 mg per  $\text{m}^3$ , a value which clearly limited algal growth. Other related ecosystem changes are discussed, including a consistent rise in nitrate concentrations in the water. **North America**

95-1590

**Hillslope nutrient flux during near-stream vegetation removal: I. A multi-scaled modelling design.**

J. A. YEAKLEY (Georgia University Athens) J. I. MEYER and W. T. SWANK

*Water Air & Soil Pollution* 1994 77, No 3/4 229-246

The effect of removal of riparian *Rhododendron maximum* L. on the export of organic matter and nutrients was being investigated in the southern Appalachians. Hillslope transects spanning topographical flow paths from a local high point to the stream were instrumented to provide data on soil moisture and water flow. Studies of nutrient flux in the riparian zone of forested catchments are reviewed. *R. maximum* was suggested as a key species at the terrestrial-aquatic interface. A model-based experimental design was formulated. The model consisted of 3 modules: objective terrain analysis, a dynamic interception canopy module, and a hillslope hydrology module with a 2-dimensional Richard's equation of subsurface moisture dynamics. Calibration and validation would be made at hillslope and catchment scales. Terrain analysis was demonstrated for the experimental catchment management of riparian zone processes discussed. Extrapolation of hillslope results to catchment scale would be possible. There are 95 references. U.S.A.

95-1591

**Monitoring lake recovery from point-source eutrophication: the use of diatom-inferred epilimnetic total phosphorus and sediment chemistry**

N. J. ANDERSON (Geological Survey of Denmark Copenhagen) and B. RIPPBY

*Freshwater Biology* 1994 32, No 3 625-639

The continuing changes to the diatom flora, water chemistry and sediment chemistry of a small monomictic eutrophic lake in Northern Ireland were studied using short cores taken in 1990 and compared with the historical phosphorus concentrations for the period 1850-1990. Background total phosphorus (TP) concentrations inferred using the diatom model were approximately 35 µg per litre and increased to more than 140 µg per litre in the late 1960s to early 1970s. Total phosphorus concentrations dropped to 80 µg per litre within 5 years of creamery waste diversion (1978-79) but varied between 1980 and 1990 (70-140 µg TP per litre). When the diatom-inferred TP concentrations were compared with monitored data, the former tended to overestimate by about 25 µg TP per litre. Post-1980 geochemistry profiles indicated some changes when compared with sediments deposited before 1980. Phosphorus concentrations in sediments had changed very little over the last 150 years and sedimentary TP fluxes did not record the effluent redirection in the mid 1970s. The implications of the use of short cores in monitoring are discussed and the value of diatom-inferred TP assessed. There are 49 references. U.K.

95-1592

**Ammonium-nitrogen: a key regulatory factor causing dominance of non nitrogen-fixing cyanobacteria in aquatic systems**

P. BLOMQUIST (Institute of Limnology Uppsala) A. PETTERSSON and P. HYENSTRAND

*Archiv für Hydrobiologie* 1994 132, No 2 141-164

Hypotheses relating to the factors influencing the dominance of cyanobacteria in freshwaters are reviewed, using data from 4 different lakes. Additional information was provided from enclosure experiments in 2 of the lakes. It was hypothesised that non nitrogen fixing cyanobacteria were highly competitive for ammonium nitrogen but much less so for nitrate-nitrogen. In the enclosure experi-

ments, cyanobacteria only developed after the depletion of nitrate nitrogen. *Merismopedia tenuissima*, a non-nitrogen fixing cyanobacteria usually predominated in the oligotrophic clear water low alkaline Njupfater lake in late summer. In a late summer experiment, dinoflagellates predominated in the enclosure to which nitrate was added but in the one in which ammonium was added, *Merismopedia* retained dominance. In an early summer experiment, nitrate addition to the enclosure led to complete dinoflagellate dominance, but ammonium addition led to joint dominance by *Merismopedia* and a dinoflagellate. In the mesotrophic lake, the growth of non nitrogen fixing cyanobacteria *Microcystis* spp and *Synechococcus* sp was enhanced by ammonium addition but not by nitrate. Eukaryotic nitrate reductase activity was induced more rapidly and more intensively than the prokaryotic nitrate reductase activity. Cyanobacteria dominance was promoted by the ability to minimize sedimentation and grazing losses in combination with the capability of non nitrogen fixers to outcompete most other phytoplankton for ammonium nitrogen or the ability for nitrogen fixing species to fix nitrogen in nitrogen deficient waters. There are 65 references. Sweden.

95-1593

**Combining Wilcoxon tests with censored data: an application to well water contamination**

L. R. KORN (New Jersey Department of Environmental Protection and Energy Trenton) E. A. MURPHY and Z. ZHANG

*Environmetrics* 1994 5, No 4 463-472

The statistical analysis of data on nitrate contamination of well water in New Jersey is considered. Statistical problems arising from measured chemical concentrations in an environmental setting concerned the presence of large outliers, observations below the limit of detection, and possible heterogeneity in dispersion of the observations in various groups of data defined by covariates. The particular properties of the data studied called for a robust or non-parametric method of analysis which could be applied to censored data. The method proposed by Zhang was applied. The analysis confirmed the hypothesis that application of nitrogen fertilizer increased the level of nitrate contamination in water from shallow wells. U.S.A.

95-1594

**Nitrite in watercourses: report of the AIV Working Party 2.14, the AIV Expert Committee 2.1 on principles of sewage treatment with regard to their discharge to receiving waters and their uses***Korrespondenz Abwasser* 1994 41, No 11 2069-2076 (in German)

The widespread introduction of nitrification and denitrification treatments as part of the purification cycle in German sewage plants meant that the role of the oxidized inorganic forms of nitrogen had gained an increasing degree of importance for the ecological quality of the receiving waters. This report presents a comprehensive review of the origins, levels of occurrence and ecotoxicological significance of nitrite in natural waters and those receiving discharges of treated sewage. Following an outline of the nitrogen cycle and of the reported incidence of nitrite in rivers in various parts of Germany (including seasonal fluctuations), the origins of nitrite pollution are reviewed, including their relationship with high ammonia concentrations, and the extent of nitrite turnover and the magnitude of inputs from sewage effluent discharges are considered. Other possible sources were the discharges from combined sewer systems overflows and non point discharges from cultivated soils and grassland, especially as a result of the application of organic manure. Some

## WATER QUALITY

conclusions regarding preventive measures and possible future trends are outlined in respect of nitrite inputs from several sources (English translation 330 pounds sterling, valid for 1995) **Germany**

95-1595

### Nitrous oxide in the western Bay of Bengal.

S. W. A. NAQVI (National Institute of Oceanography, Goa), D. A. JAYAKUMAR, M. NAIR, M. D. KUMAR, and M. D. GEORGE

*Marine Chemistry*, 1994, **47**, No. 3/4, 269-278

Surface saturations and atmospheric fluxes of nitrous oxide in western Bengal bay between March and April 1991 ranged from 89.4-213.9 per cent (mean 125.2 per cent) and from minus 0.10-10.67  $\mu\text{mol per m}^2 \text{ d}$  (mean 0.65  $\mu\text{mol per m}^2 \text{ d}$ ) respectively. The overall nitrous oxide flux from Bengal bay was estimated as 0.027-0.077 Tg nitrogen per year. The computed vertical exchange coefficient at the top of the thermocline was 0.16  $\text{cm}^2 \text{ per second}$ . There was marked accumulation of nitrous oxide in subsurface layers of Bengal bay, the total inventory of excess nitrous oxide being estimated as about 5.4 Tg nitrogen. Vertical profiles of nitrous oxide were influenced by subsurface circulation and characterized by a pronounced maximum at about 200-300 m which intensified northwards. Up to 300 m the relationship between excess nitrous oxide and apparent oxygen utilization was linear. Between 300 and 1000 m values were not significantly correlated. **India**

95-1596

### A site-specific programme for nitrate reduction, with controllable targets.

R. HIRMER (Bayerische Landesamt für Wasserwirtschaft München)

*Wasserwirtschaft*, 1994, **84**, No. 12, 652-655 (in German, English summary)

A simple procedure is outlined as a method of calculating the permissible losses of nitrogen from cultivated soils into the surface and groundwater systems. It was based on the knowledge of soil properties and their spatial variation, so that each area of similar storage capacity was considered separately, coupled with a similarly detailed knowledge of climatic variation (temperature and rainfall) and fertilizer requirements for cropping or grazing. The nitrogen inputs from atmospheric precipitation were neglected as they were compensated by the effect of denitrifying organisms in the soil. The results obtained from a detailed evaluation on a field scale would be translated into maximal permitted levels for nitrogen input from fertilizers. Where it is necessary to monitor compliance, samples of runoff and infiltrating water must be obtained and their concentrations of nitrogen determined and compared with the recommended inputs. Illustrations of the way in which the calculations are performed on a sequential basis are presented. The target values required quite stringent measures for their enforcement. (English translation 185 pounds sterling, valid for 1995) **Germany**

95-1597

### Variation and correlation of dissolved oxygen with effluent quantity and stage of river Ganga at Varanasi (India).

G. S. SINGH (Osaka University, Japan) and A. S. SINGH

*Indian Journal of Environmental Health*, 1994, **36**, No. 2, 79-83

Rainwater and effluent samples were collected fortnightly during 1990 from 35 points around the Rajghat drain, the primary outfall site for effluent reaching the Ganga river at Varanasi. Regression analyses showed a positive correlation between dissolved oxygen

(DO) and both stage of river and effluent quantity. Reduced level and effluent quantity were responsible for up to 78 per cent of the total variation in DO. Even at the minimal reduced level, a satisfactory DO content could be maintained in the river by controlling the rate of effluent discharge. **India**

95-1598

### Surface aeration.

J. F. ATKINSON (New York State University, Buffalo), S. BLAIR, S. TAYLOR, and U. GHOSH

*Journal of Environmental Engineering*, 1995, **121**, No. 1, 113-118

A model was developed for the calculation of interface transfer flux for dissolved oxygen in a river system. The model adopted the 2-film approach and film thickness was determined from either the turbulent length scale or from the Komogorov microlength scale, assuming film thickness to be related to the smallest flow eddies in the flow. The 2 approaches for estimating film thickness gave values for the re-aeration coefficient that were in good agreement with previous models under vertically mixed conditions but also allowed determination of surface oxygen flux under stratified conditions, for which some other models were inadequate. **U.S.A.**

95-1599

### Ground water resources of arid Rajasthan in relation to hydro-meteorological and chemical aspects.

D. D. OZHA (Ground Water Department, Jodhpur), G. P. BHATT, D. C. SHARMA, and P. C. JAIN

*Journal of Indian Water Works Association*, 1994, **26**, No. 2, 95-98

Hydrogeological investigations showed that nearly 65 per cent of Rajasthan was suitable for groundwater development. Owing to poor surface and subsurface drainage, the groundwater in a large part of the state was highly saline and as the rainfall increased from arid to humid regions, the groundwater quality improved. Arid areas were enriched with nitrate and fluoride in addition to their high salinity. Methods to improve water quality are suggested. **India**

95-1600

### Natural concentrations of major and trace elements in some Norwegian bedrock groundwaters.

D. BANKS (Norges Geologiske Undersøkelse Geological Survey of Norway, Trondheim) and C. REIMANN, O. ROYSETH, H. SKARPHAGEN, and O. M. SÆTHER

*Applied Geochemistry*, 1995, **10**, No. 1, 1-16

Twenty-eight groundwater samples were collected from areas in central and south-eastern Norway and examined for concentrations of some 40 major and trace elements. A definite relationship was found between the occurrence of many elements and the lithography or geological location. Certain elements including fluoride, sodium, iron, uranium, radon and possibly aluminium exceeded drinking water quality standards in some areas. The work contributed to the establishment of reference background levels for a wide range of elements. The values of analysed parameters provided a good comparison with the Dutch A' background values which were developed for anthropogenic contamination assessment. **Norway**

95-1601

**The hydrogeochemical composition of streams and lakes in Finland.**

P. LAHERMO (Geological Survey of Finland, Espoo), J. MANNIO, and T. TARVAINEN

*Applied Geochemistry* 1995, 10, No 1, 45-64

Two data sets, one from a country wide sampling programme in 1987 and the other from a stream survey in 1990, were used to examine aquatic geochemistry in Finland. The data came from 1165 stream samples with sampling points determined to include a drainage area of about 30 km<sup>2</sup> and from 1172 lake samples representing lakes in the size range of 0.01 to 10 km<sup>2</sup>. The selected determinands were sulphate, chloride, fluoride, nitrate, organic anion and colour, calcium, magnesium, sodium, potassium, aluminium, iron, pH, alkalinity and specific conductance. Anions were differently distributed in stream and lake waters. Bicarbonate ion at a concentration of about 200 µeq per litre made up more than 50 per cent of the total anion content of stream water. Stream bicarbonate ion concentrations were about triple those present in lake waters. The median concentrations of cations in both lake and stream water decreased in the same order of magnitude from calcium through magnesium, sodium, potassium, aluminium, hydrogen. Median cation totals were 260 µeq per litre in lakes and 450 µeq per litre in streams. Hydrogeochemical mapping of the data showed greater concentrations for most elements near coastal areas, particularly for streams. Lakes had a lower coastal distribution as selection was targeted on upland areas with greater lake density. Data from small lakes showed greater divergence reflecting their differences in local geology, even for adjacent lakes. The larger lakes with greater associated catchment areas had higher buffer capacity than small lakes and their chemistry was more compatible with streams. There are 39 references. **Finland**

95-1602

**Water chemistry of the Guri reservoir (rainy season 1989) - relationships between humic colour and aqueous iron and their limnological importance**

T. VELGAS VILARRUBIA (GEOHIDRACUA, Caracas)

*Archiv für Hydrobiologie* 1994, 132, No 1, 69-94

Factors regulating the metabolism and transport of elements in the Guri reservoir, a tropical blackwater man made lake on the Caroni river in Venezuela, were studied. Sampling stations were located on the inlet rivers, in the reservoir and downstream of the dam. Variables measured were dissolved oxygen, conductivity, pH, temperature, turbidity, colour, total suspended solids, chlorides, alkalinity, dissolved silicates, sodium, potassium, calcium, magnesium, and iron. Principal component analysis was used to interpret the results. Oxygen stratification was observed at all reservoir sites. The water pH was acidic and conductivity values were extremely low. Chloride concentrations were very low (1-3.5 mg per litre). Silicate concentrations showed moderate and temporal variations (1-3.5 mg per litre). Concentrations of dissolved metals varied with time. Iron concentrations and water colour increased with depth. Iron was positively correlated with conductivity and negatively with dissolved oxygen. Turbidity was correlated with iron, total suspended solids and colour. Waters leaving the reservoir were reoxygenated through natural mixing. There are 47 references. **Venezuela**

95-1603

**Comparative water quality characterization by PCA of an unperturbed and a polluted stream.**

I. PARDO (Universidad de Santiago de Compostela)

*Archiv für Hydrobiologie* 1994, 132, No 1, 95-114

Principal component analysis was used to analyse the chemical, climatic and geographical factors influencing the quality of the Louro stream and Tea stream, tributaries of the Mino river, in Spain. Parameters were measured in 1986-1988. Variables included pH, conductivity, oxygen, BOD5, nitrate, phosphate, sulphate, chloride, sodium, potassium, magnesium and calcium. In the Louro component I (incorporating 64.1 per cent of total variance) was determined by a positive relationship with inorganic salts and nutrients and a negative relationship between distance from the mouth and dissolved oxygen. Component II (15.5 per cent of total variance) represented the temporal variation of water quality. In the Tea component I (45.5 per cent of total variance) was positively associated with conductivity, chloride, nitrogen, potassium, BOD5, pH and air temperature and negatively with rainfall, discharge and dissolved oxygen. Component II (21.4 per cent of total variance) represented a spatial gradient of metallic elements along the stream. **Spain**

95-1604

**Long term changes in indices of chemical and productive status of a group of tropical Ethiopian lakes with differing exposure to human influence**

G. M. ZINABU (Awassa College of Agriculture)

*Archiv für Hydrobiologie* 1994, 132, No 1, 115-125

The water chemistry and chlorophyll *a* concentrations of the Bishoftu crater lakes, Ethiopia, were studied in 1990-1992 and the results were compared with those obtained in the 1960s. The chemistry of Kilele lake was completely different as a result of diverting the Mojo river into the lake. The 1990-1992 study showed that nitrate levels had trebled, phosphate levels had decreased by more than 200 times, and the silicate concentration had decreased to about a tenth. The conductivity had decreased 30 fold and the pH of the lake had also decreased. The chlorophyll *a* concentration had halved. Changes in the other Bishoftu crater lakes were more variable and were minimal. Nitrate, phosphate, calcium and potassium concentrations had increased and sulphate, chloride and silicate concentrations had generally decreased. **Ethiopia**

95-1605

**Major and trace elements in precipitation on western Switzerland land.**

O. ATTIA (Swiss Federal Institute of Technology, Lausanne)

*Atmospheric Environment* 1994, 28, No 22, 3617-3624

The composition of precipitation was studied over a 2 year period in weakly contaminated ecosystems in western Switzerland to determine the average concentrations of contaminants, the origin of the elements concerned, and the role of atmospheric deposition in biogeochemical cycles. The major elements studied were sodium, potassium, silicon, calcium and magnesium, together with chloride, nitrate and sulphate. The trace elements investigated were boron, vanadium, chromium, manganese, nickel, iron, zinc, copper, lead, rubidium, strontium, and barium. Most of the elements originated from seawater or the continental crust. Elements released by human activities were subject to long range transport. There are 41 references. **Switzerland**

## WATER QUALITY

95-1606

**Flooding area and sediment contamination of the river Mulde (Germany) with PCDD/F and other organic pollutants.**

M. WILKEN (ITU GmbH, Berlin), T. WALKOW, F. JÄGER and B. ZESCHMAR LAHL.

*Chemosphere* 1994, 29, No 9/11, 2237-2252.

Around 300 sediment, top soil and subsoil samples from cross-sectional and longitudinal profiles of the Mulde river flood plain catchment were analysed for polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans (PCDD/F) and other pollutants. The Bitterfeld region showed much pollution with some samples containing ppm levels. There were also inputs upstream of the region principally of DDT with its metabolites and PCDD/F. There was evidence that some of this contamination had remobilized and reached the Elbe river, part of whose floodplains contained 1000 ng toxic equivalent per kg. A major flood could transport pollutants in large quantities. High levels of tetrabutyltin in Hamburg harbour sediments probably arose from the Bitterfeld. Unless this historically polluted area was cleaned up it could seriously affect the beneficial results obtained by pollution control downstream. **Germany**

95-1607

**Historical changes in the ecological health of the Newark bay estuary, New Jersey**

D. W. CRAWFORD (ChemRisk, Portland, Me.), N. I. BONNEVILLE, C. A. GILLIS and R. J. WENNING.

*Ecotoxicology and Environmental Safety* 1994, 29, No 3, 276-303. The health of the Newark bay ecosystem over the past century was evaluated and the various environmental stressors likely to have resulted in impaired ecological conditions are examined. Historical trends in various water quality parameters and sediment levels of toxic contaminants throughout the estuary are reviewed and summarized. The available data indicated that the diversity and abundance of aquatic species within the estuary had been substantially reduced since the late 1800s due to intense industrialization and urbanization. Water and sediment quality in major rivers and bays linked to the estuary had also been severely impacted and a significant amount of natural habitat destroyed due to industrial development, urban expansions and shoreline modifications. These parameters all affected the overall health of the ecosystem. Due to pollution control measures and the reduction in environmental stressors, there had been a gradual improvement in the ecosystem over the past 2 decades. There are 143 references. **U.S.A.**

95-1608

**A further investigation of sources of pollution in Leeuwarden (The Netherlands).**

C. ROOS (Witteveen & Bos), R. M. van den BOOMEN and R. VENNINGEN.

*W20* 1994, 27, No 26, 773-777 (in Dutch, English summary, p. 761). Preliminary results are presented of an investigation into the sources of urban wastewaters in Leeuwarden, to characterize them, and to ascertain into which waterway they flowed. Maps of the area are given, showing the categories into which the surface waters are classified, together with the major components of the effluents in them. An indication of which portions of the waterway network would comply with, and which fail, the national general standards for the specified components is shown. (English translation 210 pounds sterling, valid for 1995). **Netherlands**

95-1609

**Atmospheric pollutants and their effects on quality of water.**

N. C. GHOSH (National Institute of Hydrology, Roorkee) and S. M. SETH.

*Indian Journal of Environmental Health*, 1994, 36, No 2, 104-114.

The chemistry of atmospheric pollutants and the mechanisms of their deposition are considered. The urban environment, forest canopies, rime ice and snow covers all influenced precipitation. Atmospheric pollutants affected the physical, chemical and biological characteristics of water. **India**

95-1610

**Water quality in Jayanthi Nalla and Panchaganga at Kolhapur.**

B. B. HOSETTI (Kuvempu University, Shimoga), A. R. KULKARNI and H. S. PATIL.

*Indian Journal of Environmental Health* 1994, 36, No 2, 124-127.

Jayanthi Nalla was a freshwater stream originating from Kalambe lake. It received effluent discharges and became polluted before it joined the Panchaganga river. Physico-chemical characteristics of the lake, Nalla and river were assessed and the impact on river water quality was evaluated. Industrial effluent needed to be treated before discharge into the Nalla. **India**

95-1611\*

**Effects of land disposal of municipal sewage sludge on fate of nitrates in soil, streambed sediment, and water quality.**

J. A. FINDALL (U.S. Geological Survey, Denver, Colo.), K. J. LUI and N. G. GAGGIANI.

*Journal of Hydrology* 1994, 163, No 1/2, 147-185.

The effect of sewage sludge disposal at the Lowry disposal site near Denver, Colo., on soil, streambed sediment and water quality was investigated over a 6 year period. Sources of leachate were also monitored, with particular attention to nitrate. The extent and rate of movement of the plume of affected groundwater and the potential for additional sludge leaching at the site were examined. Thirteen wells in an alluvial aquifer in the study area contained water which was probably affected by sludge leachate. The disposal area appeared to be responsible for increased nitrite and nitrate concentrations in alluvial groundwater at the site. Higher levels of sodium, calcium, magnesium, sulphate, bicarbonate and chloride were also noted. **U.S.A.**

95-1612

**Rainfall-related pollution of watercourses: identification and evaluation of critical pollution events, quantification of their effect and costs of further remedial measures.**

G. MEHLHART (Universität Gesamthochschule Kassel).

*Korrespondenz-Abwasser* 1994, 41, No 11, 1994-2003 (in German, English summary).

As the application of advanced treatment methods at sewage treatment plants becomes more widespread, the level of pollution associated with discharges of stormwater and related direct inputs to receiving waters becomes more critical for the maintenance of an acceptable water quality. For a preliminary check on the significance of such discharges, an estimate of the magnitude of the inputs during periods of low streamflow is advisable. The ecological effects of such shock loadings being evaluated with reference to the concentration of ammonia downstream from a given outfall. Methods of performing these calculations are described based on a combination of direct observation and time series analyses, and the benefits of allowing a higher proportion of the stormwater flow to undergo treatment are

examined. By increasing the proportion of stormwater in the combined sewage flow entering the treatment plant by around 50 per cent a major reduction in the pollution load entering the receiving water could be achieved, equivalent to the provision of additional retention capacity amounting to 40 m<sup>3</sup> per ha or reducing the paved surface area by 20 per cent. (English translation 320 pounds sterling valid for 1995) **Germany**

#### 95-1613\*

##### **Herbicides and nitrate in near-surface aquifers in the midcontinental United States, 1991**

D. W. KOLPIN, M. R. BURKART and F. M. THURMAN

U.S. Government Printing Office, Washington, D.C. Geological Survey Water-Supply Paper No 2413, 1994, 34pp.

The incidence and distribution of selected herbicides, including metabolites of atrazine and nitrate ions in the near-surface aquifers (up to 50 ft below ground) were investigated in the corn and soya bean growing areas of central U.S.A. Water samples were collected during spring and summer 1991 from 303 wells in a total of 12 states, including unconsolidated and near-surface bedrock formations. The results are analysed with respect to the nature of the herbicide (or its metabolite), geographical location and hydrogeologic factors such as land use and cropping practices. Herbicides and excessive nitrate levels were detected more frequently in groundwater from the unconsolidated than the near-surface bedrock formations. The depth to the top of the aquifer was inversely related to the frequency of detection while the proximity of streams to the boreholes also affected the frequency of herbicide occurrence. Significant seasonal differences were observed in respect of herbicides but not for excess nitrate (levels of over 3 mg per litre). Levels of nitrate exceeding the U.S. EPA maximal contaminant level for drinking water of 10 mg per litre were found in 6 per cent of samples. **U.S.A.**

#### 95-1614

##### **Fluorides in ground waters of Unnao (U.P.) and Shivpuri (M.P.) districts**

M. RAMA RAO (Indian Institute of Technology, Kanpur), C. S. SHAJI, L. IYENGAR and C. VENKOBACHAR

*Journal of Indian Water Works Association*, 1994, **26**, No 3, 180-181.

Fluoride was analysed by the SPADNS method, replacing cyclohexylenediaminetetraacetic acid in the total ionic strength adjusting buffer with sodium citrate. Concentration of fluoride in groundwater were dependent on the nature and location of the source and the depth of the water stratum. Adjustment of draw-off position to reduce fluoride concentrations was preferred to the installation of fluoride removal treatment. **India**

#### 95-1615

##### **The sensitivity of surface waters of Great Britain to acidification predicted from catchment characteristics**

M. HORNUNG (ITE, Granges over Sands), K. R. BULL, M. CRESSER, J. ULLYETT, J. R. HALL, S. LANGAN and P. J. LOVELAND

*Environmental Pollution*, 1995, **87**, No 2, 207-214.

A map indicating the sensitivity of surface waters to acidification was derived from soil, land use and geological information; the latter using an existing but slightly modified map. Soil sensitivity determined by buffering capacity was derived from 1 km databases of soil information. Derived soil maps were modified to account for agricultural liming in arable and managed grassland. Data were merged using a geographic information system and a final sensitivity classifi-

cation made on the basis of expert knowledge and experience of a similar process in Wales. **U.K.**

#### 95-1616

##### **Long-term changes in water and soil chemistry in spruce and beech forests, Solling, Germany**

L. G. WESSELINK (Agricultural University Wageningen, Netherlands), K. J. MEIWEES, E. MATZNER and A. STIN

*Environmental Science & Technology*, 1995, **29**, No 1, 51-58. The long-term changes in the chemistry of bulk precipitation, throughfall water, soil water and exchangeable base cations in German forests were examined for the period 1969-1991. Although analytical methods changed during this time, comparability was ensured. Changes were sought by linear regression models with autocorrelated errors. Time trends in dissolved and exchangeable pools of base cations in the soils were compared with simulations from a simple mechanistic soil chemistry model to identify the processes controlling long-term changes in soil chemistry. Until 1976 there had been much acidification in the soils from sulphate deposition. The latter decreased significantly after this period, but acidification continued in the spruce soil as atmospheric deposition of calcium and magnesium fell, but soil dissolved sulphate concentrations remained high. These factors were less pronounced in the beech soil, so the reduced sulphate deposition resulted in a recovery in the soil's base saturation in the 1980s. There are 40 references. **Germany**

#### 95-1617

##### **Alkalinity and total carbonate in the Arabian Sea: Carbonate depletion in the Red Sea and Persian Gulf**

L. ANDERSON (Chalmers University of Technology and Gothenburg University, Sweden) and D. DYRSSEN

*Marine Chemistry*, 1994, **47**, No 3/4, 195-202.

The annual decrease in alkalinity in the Persian Gulf and Red Sea was estimated as 0.326 and 1.650 Tmol per year, respectively. This amounted to a loss of carbon as calcium carbonate of 12 Mtons per year, about 5 per cent of the annual river input of carbon as hydrogen carbonate. There was an increase in the depth profile of specific alkalinity below 600 m. The depth profile of alkalinity inorganic carbon showed low values below the euphotic zone. A site selected to show the relationship between alkalinity inorganic carbon and the concentration of phosphate and nitrate plus nitrite showed that a slope of 15 fitted the phosphate data except in deep water where dissolution of carbonate might produce high values of alkalinity inorganic carbon. The slope of 105:15 for C:N did not fit the data and showed a loss of nitrogen due to denitrification, the nitrogen loss being 45.5 per cent between 215-285 m. **Saudi Arabia**

#### 95-1618

##### **Impact of land use and soil type on the contribution of sulphate to total sulphur in drainage water from upland soils**

T. A. AROWOLO (Aberdeen University), M. S. CRESSER and A. C. EDWARDS

*Science of the Total Environment*, 1994, **158**, 139-146.

Air-dried samples of a range of northern U.K. soils were analysed for pH, total carbon, total nitrogen, total sulphur and various forms of sulphur. Soil solutions obtained by centrifuging the original soil samples were also analysed. Up to 50 per cent of the sulphur in soil solution was non-sulphate organic, a component which if ignored would cause inaccurate catchment sulphur budgets. No single or simple combination of soil factors explained the distribution and amount of sulphur. Carbon to sulphur ratios and the relative



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amounts of sulphur leached in organic form probably depended on soil chemistry, vegetation types, variations in atmospheric deposition and soil management history. Interpretation was also complicated by biological transformations and selective sorption properties of top soil compared with sub-soil as sulphur-containing solutions migrated. There are 13 references. U.K.

95-1619

**Chemical characterization of sediments and pore water from the Upper Clark Fork river and Milltown reservoir, Montana.**  
W. G. BRUMBAUGH (Midwest Science Center, Columbia, Mo.)  
C. G. INGERSOLL, N. E. KEMBLE, T. W. MAY and J. L. ZAJICEK

*Environmental Toxicology and Chemistry*, 1994, 13, No 12, 1971-1981

As part of a baseline risk assessment programme initiated in 1989 by the U.S. EPA at the Milltown reservoir Superfund site in Montana, U.S.A., physical and chemical characteristics of surficial sediment samples from the upper Clark Fork river and Milltown reservoir were analysed. Concentrations of arsenic, cadmium, copper, manganese, lead and zinc in surficial sediments from depositional zones decreased gradually downstream in the Clark Fork river but then increased in the Milltown reservoir stations. Metal chemistry in river and reservoir sites was generally similar. Large percentages (50-90 per cent) of total cadmium, copper, lead and zinc were extractable by 1N hydrochloric acid. Copper and zinc accounted for over 95 per cent of the extractable metals on a molar basis. Acid-volatile sulphide (AVS) concentrations were moderate in most samples and appeared to regulate dissolved metal concentrations in sediment pore water. Dissolved cadmium, copper and zinc concentrations were relatively high in pore waters of sediments that were low in AVS. There are 45 references. U.S.A.

95-1620

**Speciation of iron and manganese in dam water particles using electron spectroscopy for chemical analysis (ESCA).**

M. ZAW (Australian Nuclear Science and Technology Organization, Menai, N.S.W.) and B. CHISWELL

*Falanta*, 1995, 42, No 1, 27-40

Samples taken at various depths and seasons from North Pine dam near Brisbane, Australia, were used to build up a water column profile. The speciation of iron and manganese compounds retained by membrane filtration was studied using electron spectroscopy for chemical analysis (ESCA). ESCA results showed that iron(III) compounds predominated in the whole water column in any season of the year. Iron(II) species varied in the hypolimnion (bottom layer). In summer, manganese(IV) compounds predominated in the epilimnion (top layer) while both manganese(II) and manganese(IV) predominated in the metalimnion (middle layer) and the hypolimnion. Various ratios of manganese(II), manganese(III) and manganese(IV) compounds occurred down the water column. The majority of manganese(IV) compounds were found throughout the water column after heavy rain and winter season. The ratios of atomic concentrations of iron and manganese (determined by ESCA and atomic absorption spectrometry) are also discussed. There are 35 references. Australia.

95-1621

**Aluminium speciation variations in an acidic upland stream draining the Hafren spruce forest, Plynlimon, Mid-Wales.**

C. NEAL (Institute of Hydrology, Wallingford)

*Journal of Hydrology*, 1995, 164, No 1/4, 39-51

An established model based on an equilibrium thermodynamic approach was used to investigate the speciation of aluminium in an acidic stream draining a spruce forest, the Hafren forest in Mid-Wales. Estimates of aluminium complexation with hydroxide, fluoride and sulphate and with dissolved organic matter and silica were obtained. Trivalent aluminium and aluminium complexes with fluoride with dissolved organic matter and with silica were abundant while aluminium hydroxy-fluorides and sulphates were much less so. There was a larger scatter in the data, principally due to variations in stream water chemistry at a given pH. There are 40 references. U.K.

95-1622

**Application of a mass balance model to assess in-place arsenic pollution.**

M. I. DIAMOND (Toronto University, Ont.)

*Environmental Science & Technology*, 1995, 29, No 1, 29-42

Arsenic dynamics and mobile arsenic arising from sediments in the basins of Moira lake in eastern Ontario were described by a simple steady-state mass balance model based on equivalence as an equilibrium criterion and an established quantitative air-water-sediment interaction model. The model was calibrated for conditions before the lake was polluted, while the incoming arsenic load was high and lastly when the external load had been drastically reduced. Monitoring data had indicated that, although the lake had been a net sink for arsenic when incoming levels were high, it was now releasing the element. The model was used in conjunction with the linear additivity principle to distinguish contributions from current loadings and in-place pollution and to quantify downstream movement of in-place pollution. The latter depended on sediment-water exchange which was dominated by sediment resuspension. As inputs of arsenic fell, the sediments became increasingly a source of arsenic, so that further decisions on controlling upstream arsenic contributions should be taken in the knowledge that the lake itself was becoming an important source. There are 58 references. Canada.

95-1623

**Sunlight-induced formation of dissolved gaseous mercury in lake waters.**

M. AMYOT (York University, North York, Ont.)  
G. MIERLI, D. R. S. LEAN and D. J. McQUEEN

*Environmental Science & Technology*, 1994, 28, No 13, 2366-2371

The effects of sunlight and hydrogen peroxide on dissolved gaseous mercury (DGM) production in lake water were studied. The effect of UV-B light (280-320 nm) was assessed. Samples incubated in transparent bottles yielded DGM levels that were 2.4-8.9 times higher than those kept in black bottles. DGM production rates varied seasonally, ranging from 182 fM per h in August to 17 fM per h in November. UV-B light was responsible for less than 25 per cent of the DGM production. Hydrogen peroxide did not have a significant role. The presence of a diel pattern of DGM production in surface water was investigated. The highest DGM levels were observed at noon and the lowest ones at 6.00 AM, just before sunrise. Depth profiles of DGM concentrations were obtained to identify the site of maximal DGM production in the water column. DGM levels of up to 256 fM were found in the epilimnion, decreasing to 59 fM at 6 m

and increasing in the hypolimnion to 100 fM. It is hypothesized that the primary process for DGM production in lakes was the biological or photochemical reduction of mercury in the epilimnion by visible light or UV-A light. **Canada**

## 95-1624

**Preliminary study of the redistribution and transformation of HgS from cinnabar mine tailings deposited in Honda bay, Palawan, Philippines.**

G. BENOIT (Yale School of Forestry and Environmental Studies, New Haven, Conn.), J. M. SCHWANTES, G. S. JACINTO and M. R. GOUD COLLINS

*Marine Pollution Bulletin*, 1994, 28, No 12, 754-759

Cinnabar mine tailings from mining operations in Palawan, the Philippines, were used in the construction of a 600 m long peninsular in Honda bay. Samples from the peninsular and from sediments from surrounding water contained mercury at concentrations up to 570 ppm. Natural processes transported mercury up to 10 km from the peninsular in a principally coastwise direction. Mercury was preferentially associated with fine grained organically rich sediments and penetrated over 10 cm into sediments near the source. As cinnabar was transported away from the peninsular, it was rapidly converted to bioavailable forms with up to 50 per cent conversion occurring within 10 to 40 m. **U.S.A.**

## 95-1625

**Chemical and isotopic examination of produced waters from the BP-Wolf lake *in situ* combustion pilot.**

I. HU, T. CHEON (Calgary University, Alta.), M. SHEVALLER, C. NAHNYBIDA and H. R. KROUSE

*Applied Geochemistry*, 1995, 10, No 1, 65-83

The isotopic and chemical composition of waters coproduced in oil reservoirs heated by *in situ* combustion were used to examine the combustion processes that took place in the BP-Wolf lake pilot site in Alberta. The processes included production of carbon dioxide and dissolved sulphate, the mixing of water, and variations in water chemistry that arose from heated zones. Water resources included overlying and underlying aquifers, pore water in oil bearing strata and waters from the combustion process and the injection of steam. Mixing behaviour was complex, with multiple water sources and rock and water reactions acting to modify water composition. Formation water, injected steam and combustion generated water were identified by chemical differentiation but pore waters and aquifer sources were indistinguishable. The approach of the combustion front could be monitored by dissolved species such as silicon dioxide, the sodium/potassium ratio and chloride. Sulphate was less reliable. Significant water and rock reactions were indicated from isotope composition of produced waters. From the evidence of carbon isotope composition of bicarbonate ion, oil oxidation at high temperatures was the major producer of carbon dioxide but at lower temperatures carbon dioxide produced by mineral carbonate dissolution became significant. Combustion derived sulphate concentrations were up to an order of magnitude greater than that which arose from steam heating. Both the oil and pyrites were contributory sulphur sources, though isotopic examination suggested that the high sulphate concentrations associated with the advance of the combustion front resulted from pyrite oxidation. There are 35 references. **Canada**

## 95-1626

**Leaching from stone crab traps dipped in Fungitrol: diesel fuel preservative.**

J. S. BARRE (South Florida University, St. Petersburg) and F. S. van VLEET

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 6, 813-819

Pine and cypress slats were soaked in a 1:10 mixture of Fungitrol with diesel fuel for 10 d, allowed to weather for up to 8 weeks, and then submerged in seawater. Diesel fuel hydrocarbons extracted from wood samples at various times during this process were analysed. All measurements were expressed in terms of the surface area of wood used to make a stone crab trap. After dipping the pine slats had absorbed the equivalent of 1.56 litres of diesel fuel per trap, and the cypress slats had absorbed 2.04 litres per trap. During the 8 week weathering period the diesel concentration decreased by 84 per cent in the pine and by 92 per cent in the cypress. Seawater immersion could remove virtually all the remaining hydrocarbons, showing the importance of adequate weathering to avoid hydrocarbon pollution of the water. **U.S.A.**

## 95-1627

**The fate of the oil spilled from the Exxon Valdez: the mass balance is the most complete and accurate of any major oil spill.**

D. A. WOLFE (National Oceanographic and Atmospheric Administration, Silver Spring, Md.), M. J. HAMILLE, J. A. GALT, G. WATABAYASHI, J. SHORE, C. OCCLAIRE, S. RICE, J. MICHEL, J. R. PAYNE, J. BRADDOCK, S. HANNA and D. SALT

*Environmental Science & Technology*, 1994, 28, No 13, 560A-568A

The Exxon Valdez grounded on a reef in Prince William Sound, Alaska on March 24, 1989, spilling 10.8 million gallons of crude oil into the Sound. The processes that affected the distribution and transformations of the spilled oil were investigated and a spatial-temporal mass balance to autumn 1992 was constructed. Processes that affected the fate of the oil are discussed: evaporation, distribution of hydrocarbons in air, recovery or destruction of floating oil, dispersion and dissolution, photolysis, and biodegradation in the water column, transformations of beached oil, recovery and disposal of solid oily wastes, shoreline treatment, bioremediation, biodegradation, transport of oil to subtidal sediments. It was estimated that 20 per cent of the spilled oil evaporated and underwent photolysis in the atmosphere, 50 per cent was degraded, 14 per cent was recovered or disposed of, 1 per cent remained in the water column, 2 per cent remained in intertidal shorelines, and 13 per cent remained in subtidal sediments. There are 60 references. **U.S.A.**

## 95-1628

**Speciation of EDTA in natural waters: exchange kinetics of iron-EDTA in river water.**

H. XUÉ (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Kastanienbaum), I. SIGG and E. G. KARI

*Environmental Science & Technology*, 1995, 29, No 1, 59-68

The exchange kinetics of iron(III)-EDTA with zinc and calcium were studied in natural river water. EDTA was measured by converting to propyl esters and analysing by gas chromatography. The exchange of the iron(III) complex with zinc was followed by voltammetric measurement of labile zinc and by the disappearance of the iron complex measured as a photolabile species. The second order rate constant for this exchange was  $10.3 \text{ per mol second}$ , the dissociation

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of iron(III)-EDTA appeared to be the rate-limiting step. The exchange of zinc with calcium-EDTA was much faster with a second order rate constant of 1100 per mol.second. The exchange of iron(III)-EDTA in river water had a half life of around 20 d. If a complex such as this was initially present, then it would determine the fate of EDTA in most river waters since equilibrium between EDTA and other metal species would probably not be attained in the time scale of river flow. The theoretical background is explained. **Switzerland**

95-1629

### **Nonpoint-source groundwater contamination by 1,2,2-trichloropropane, a trace impurity in soil fumigant formulations.**

S. Y. SZETO (Agriculture Canada, Vancouver, B.C.), G. GROVE, H. LIEBSCHER, B. HILL, and B. J. ZEBARTH. *Journal of Environmental Quality*, 1994, 23, No. 6, 1367-1370. Pesticide contamination of the Abbotsford aquifer, B.C., Canada, was investigated by analysing 514 groundwater samples from 60 piezometers and 23 domestic wells during a 13-month period. Purge-and-trap capillary gas chromatography-mass spectrometry detected a new contaminant, 1,2,2-trichloropropane (1,2,2-TCP) in 296 samples which was confirmed by full scan mass spectrometry. Water collected from 34 piezometers (57 per cent) and 10 wells (44 per cent) contained 1,2,2-TCP. Mean concentrations were 0.12 ug per litre for piezometers and 0.14 ug per litre for domestic wells with maximal concentrations of 0.62 ug per litre and 0.32 ug per litre, respectively. Samples of the soil fumigants Telone (1,3-dichloropropene and 1,2-dichloropropane) and Telone II (1,3-dichloropropene) for controlling pathogenic nematodes in raspberry production contained 0.1-0.3 per cent of 1,2,2-TCP by weight as impurities and the presence of 1,2,2-TCP in groundwater probably resulted from previous pesticide application in the study area. Trace concentrations of an impurity in a pesticide could result in significant groundwater contamination under appropriate soil and climate conditions. **Canada**

95-1630

### **Herbicide interchange between a stream and the adjacent alluvial aquifer.**

W. WANG (U.S. Geological Survey, Columbia, S.C.), and P. SQUILLACE. *Environmental Science & Technology*, 1994, 28, No. 13, 2336-2344. Herbicide interchange between a stream and the adjacent alluvial aquifer, and quantification of herbicide bank storage during high streamflow were investigated on the Cedar river floodplain, Iowa, U.S.A. During base-flow conditions in February 1990 the hydraulic gradient was from the aquifer to the river. Atrazine concentrations were stratified with largest concentrations near the land surface. The atrazine metabolite desethylatrazine was distributed more uniformly with mean concentrations of 0.13 ug per litre. Concentrations of ametryn, metribuzin, prometon, prometryn, simazine, and terbutryn were lower than the detection level. During high streamflow in May 1990 large concentrations of all herbicides were detected in the river. Concentrations of atrazine, alachlor, cyanazine, and metolachlor were 3, 5, 2.6, and 5.5 ug per litre, respectively. During flooding in June 1990, concentrations of alachlor, atrazine, cyanazine and metolachlor were 0.37, 3.8, 0.67, and 1.2 ug per litre, respectively. During March 1990, herbicide bank storage of alachlor, atrazine and metolachlor was evident in well water 20, 50 and 10 m from the river's edge. Herbicide bank storage could be quantified by multi-

plying herbicide concentration by effective area represented by well and an assumed porosity. **U.S.A.**

95-1631

### **Threats to water quality from pesticides - case histories from Denmark.**

A. HELWEG (Danish Institute of Plant and Soil Science, Slagelse). *Pesticide Outlook*, 1994, 5, No. 5, 12-18. Incidents of pesticide contamination of water supplies are described. Situations which need to be guarded against include direct contamination of wells during filling of sprayers, pesticide treatment near wells and well borings, repeated filling and rinsing of tractor sprayers in one place, particularly when on soils of low organic content, improper disposal of waste pesticides, pesticide use during autumn and winter and the use of leachable herbicides for total weed control on mineral soils. The source of pesticide contamination of groundwater needs to be traced so that it can be made clear that agricultural use is possible without exceeding the EC drinking water limits for pesticides. **Denmark**

95-1632

### **The rise and fall of PCBs: time-trend data from temperate industrialized countries.**

G. SANDERS (Lancaster University), S. J. EISENREICH, and K. C. JONES. *Chemosphere*, 1994, 29, No. 9/11, 2201-2208. The chronological input pattern of PCB in the U.K. is discussed with evidence from 4 lacustrine sediment cores, one ombrotrophic peat core, 2 sets of archived soils and herbage samples. Accumulation rates and dating were carried out by measuring lead-210, caesium-137 and caesium-134. All methods showed 1963-1970 as the period of maximal input, since then, a substantial fall in PCB had occurred which was mirrored in the U.S.A. The more chlorinated congeners were at higher concentrations in the sediments and peat compared with herbage. In some cases, sediment dating was difficult through mixing, disturbances during sampling, and advection of isotopes. The results demonstrated a decline in PCB concentrations but further work was required to identify the fate of the compounds and their concentration trends in predator species. **U.K.**

95-1633

### **Are PCBs in the Great Lakes approaching a new equilibrium?**

D. W. SMITH (BCM Engineers, Inc., Plymouth Meeting, Pa.). *Environmental Science & Technology*, 1995, 29, No. 1, 42A-46A. The U.S. EPA's view that contaminants in the Great Lakes, particularly PCB, were reaching a new equilibrium with external sources is critically examined. The view was based on 4 assumptions: that the rate of decline of PCB in Michigan lake fish was falling with time; that a first order rate of decline was an appropriate model; that short-term changes in fish tissue concentrations reflected changes in ambient levels and external loadings; and that a new equilibrium was possible. All these assumptions were considered unsound because of inappropriate statistical interpretation and a misunderstanding of prey dynamics. As a consequence, the Great Lakes Water Quality Guidance proposed by the U.S. EPA had no firm basis and required reconsideration. **U.S.A.**

95-1634

**Utility right-of-way contaminants: polycyclic aromatic hydrocarbons.**

M. T. WAN (Environment Canada, North Vancouver, B.C.)

*Journal of Environmental Quality*, 1994, 23, No 6, 1297-1304

Extracts of ditch water and sediment samples collected from utility railway, parkland and farmland sites during 3 consecutive periods of maximal runoff and of samples of soil and chlorophenol (CP)/creosote-treated wood from utility power poles and railway ties were analysed by gas chromatography-mass spectrometry. High levels of 15 common PAH were detected in treated wood with concentrations of approximately 62,000 and 16,000 mg total PAH per kg in poles and railway ties, respectively. No PAH were detected in parkland ditches but all compounds occurred in farmland and utility right-of-way ditches. Total PAH concentrations in utility ditches 4 m upstream and 4 m downstream of power poles were 3 and 23 µg per litre respectively compared to 552 µg per litre in ditches adjacent to the pole. No PAH occurred in parkland ditch sediments while total concentrations of 15 mg per kg were recorded in utility ditch sediment adjacent to a power pole and 3.3 mg per kg at sites 4 m downstream where PAH residues were detected consistently. Ballast soils at pole bases contained 3076 mg PAH per kg. Methods of reducing PAH in utility drainage which could have chronic toxic effects on fish and aquatic invertebrates are discussed. **Canada**

95-1635

**Particle-associated PCBs in lake Ontario.**

A. M. DROCH (National Water Research Institute, Burlington)

Ont., K. L. E. KAISER, M. L. COMBA and M. NEILSON

*Science of the Total Environment*, 1994, 158, 113-125

The role of the nepheloid layer in the transport and cycling of PCB was studied in 1987-1989 and 1991. Water, suspended matter and bottom sediment samples were taken, the suspended solids being concentrated by continuous centrifuge. Major elements were determined by X-ray fluorescence spectrometry and PCB by gas chromatography after extraction and clean up. The levels of total PCB in the suspended matter of the nepheloid layer were 151-728 ng per g dry weight in the first survey, compared with 405 ng per g dry weight in the top 3 cm of sediments. Tetra- and pentachlorobiphenyls and other lower chlorinated PCB were more prevalent in the suspended sediments than the bottom sediments. The greatest concentrations up to 4100 ng per g dry weight were found in suspended sediments at 15 m above the lake bottom. The results indicated the association of total PCB with allochthonous particles originating principally during the summer months in surface waters which were sinking through the water column. **Canada**

95-1636

**Input and behaviour of linear alkylbenzenesulphonates (LAS) in a stratified estuary.**

S. TERZIC (Institute Ruder Boskovic, Zagreb) and M. AHEI

*Marine Pollution Bulletin*, 1994, 28, No 12, 735-740

The input and distribution of linear alkylbenzenesulphonates (LAS) in the highly stratified Krka river estuary were studied between 1990 and 1991. LAS homologues, determined by reversed phase HPLC with spectrofluorimetry, contained chain lengths of 10 and 13 carbon atoms at concentrations between 285 and 1041 µg total LAS per litre. Input into Sibenik harbour was 1.2 kg per d. Between 11 and 59 per cent of the LAS was particulate. Distribution of homologues varied between dissolved and particulate fractions. Particulate fraction contained enhanced concentrations of carbon chains of 12 and 13 atoms. LAS concentrations in the estuary were low (0.2 to 23.9 µg per litre)

and were attributed to strong and fast dilution. Characteristic vertical distribution of LAS in the estuarine water column indicated that the wastewater plume spread almost exclusively in the upper brackish layer. Concentration maxima were observed in the surface micro-layer and at the brackish water-seawater boundary. **Croatia**

95-1637

**Sulphonated derivatives of naphthalene in water samples of an Italian river.**

O. ZERBINATI (Universita di Torino), S. SALOMONE, and G.

OSTACOLI

*Chemosphere*, 1994, 29, No 12, 2639-2643

Water samples were collected over a 72 km length of Boemuda river and analysed for aromatic sulphonates. Samples were taken during the time that a chemical plant was discharging such chemicals into the river, and about one year after discharges stopped. Contaminant concentrations in upstream samples were not measurable. Aromatic sulphonate concentrations decreased downstream from the chemical plant, except for samples taken from an underground spring which were about a 1000 times higher than all other samples, and which might have been polluted from landfills. Pollutants were still present in the later samples, although generally at lower concentrations. **Italy**

95-1638

**Formation and transport of deethylatrazine and deisopropylatrazine in surface water.**

E. M. THURMAN (U.S. Geological Survey, Lawrence, Kans.)

M. J. MEYER, M. S. MILLS, E. R. ZIMMERMAN, C. A.

PERRY and D. A. GOODSBY

*Environmental Science & Technology*, 1994, 28, No 13, 2267-

2277

Runoff patterns of the triazine metabolites deethylatrazine (DEA) and deisopropylatrazine (DIA) were determined in field disappearance studies of the herbicides atrazine and cyanazine in the Midwest Corn Belt, U.S.A. The concentrations of DEA and DIA in surface water varied with the hydrological conditions of the basin and with timing of the runoff. The concentration of cyanazine was greatest in the first runoff event and then decreased in approximately 40 d. The concentration of DIA increased gradually from 2 per cent to 25-35 per cent. Atrazine showed an exponentially decreasing curve from the surface runoff. The concentration of DEA gradually increased. Atrazine and cyanazine plots had disappearance half-lives of 5.9 days and 8 d, respectively. The DIA/DEA ratios varied from 0.4 when atrazine was the major triazine present to 0.6 when significant amounts of cyanazine were present. There are 40 references. **U.S.A.**

95-1639

**Fractionation of fulvic acids, characteristics and complexation with copper.**

C. F. LIN (National Taiwan University, Taipei), D. Y. LEE, W. J.

CHEN and K. S. LO

*Environmental Pollution*, 1995, 87, No 2, 181-187

Fulvic acids isolated from Suwannee river and Peetsuey reservoir were separated by gel filtration chromatography into 3 molecular weight ranges: less than 220, 220-1000 and 1000-4000. Conditional stability coefficient (CSC) and kinetic parameters of complexation at pH 6.5 with 0.065 M copper were determined by fluorescence quenching. CSC of each fraction was between 0.009 M and 0.033 M. Forward and reverse rate constants were 0.0069 to 0.0124 M per

## WATER QUALITY

second and 0.035 to 0.08 per second respectively. Copper transport modelling is considered. There are 31 references. China

95-1640

### **The distribution of radionuclides between the dissolved and particulate phases of a contaminated freshwater stream.**

R. N. MURDOCH (Liverpool University), M. S. JOHNSON, J. D. HEMINGWAY and S. R. JONES

*Environmental Technology* 1995, 16, No 1, 1-12

Water samples were taken from 3 sites on a stream receiving leachate from a low level radioactive waste disposal site. Particles were separated by filtration through a 0.2 µm membrane. The chosen radionuclides were separated and measured. Total radionuclide concentrations were linearly related to the logarithm of stream flow. Eighty per cent of plutonium 239/240 was dissolved while caesium 137 and americium 241 were equally divided between solid and liquid phases. Caesium 137 was either dissolved or its ion was adsorbed on to particles. The proportions of americium 241 and plutonium 239/240 associated with particles were probably bound to sediment coatings such as oxides/hydroxide or organic materials. Soluble plutonium 239/240 and to some extent americium 241 were probably associated with fulvic or humic acids. Distribution coefficients were determined for a number of discrete sites. When the leachate was redirected straight to the sea, the amount of caesium 137 in the stream fell to almost undetectable levels. Plutonium 239/240 became more associated with the solid phase while the reverse occurred for americium 241. There are 34 references. U.K.

95-1641

### **Radionuclide transport above a near-surface water table. I. An automated lysimeter facility for near-surface contaminant transport studies.**

S. BURNE (Imperial College, London), H. S. WHEATLER, A. P. BUTLER, P. M. JOHNSTON, P. WADEY, G. SHAW and J. N. B. BELL

*Journal of Environmental Quality* 1994, 23, No 6, 1318-1329

A field lysimeter system was designed for characterizing the upward migration of contaminants from subsurface sources into the near-surface soil-water zone in a vegetated soil. Fixed water table depths of 35 cm and 65 cm were maintained in instrumented concrete lysimeters by automatic control systems in auxiliary buffer tanks. A mixture of 6 radionuclides including beta and gamma emitters of widely varying sorption characteristics representing reactor waste and nuclear fuel reprocessing products was introduced to an inert substrate of polyethylene beads below the water table and recirculated to provide uniform groundwater concentrations. Water movements, the vertical distribution of soil water potential and soil temperature and climatological variables were monitored continuously and soil moisture content, crop variables and radiochemical concentrations were measured regularly. Soil cores were drilled from the lysimeters before and after harvest for radiochemical analysis. Illustrative data obtained during the first 2 years of operation which differed markedly in climatic conditions demonstrate that the system enabled full descriptions of the climatic and hydrological controls on contaminant migration and of the biological response (see also following abstract). U.K.

95-1642

### **Radionuclide transport above a near-surface water table: II. Vertical distribution of gamma activities within soil profiles in relation to wheat rooting density and soil-to-plant transfers.**

P. WADEY (Imperial College, Ascot), G. SHAW, J. N. BELL, and M. J. MINSKI

*Journal of Environmental Quality* 1994, 23, No 6, 1330-1337

Radiochemical results are presented for the first 2 years' operation of a lysimeter system designed to investigate upward contaminant migration in the near-surface unsaturated zone which was sown with winter wheat (*Triticum aestivum*). The distribution of 4 gamma-emitting radionuclides introduced below 35 cm (shallow) and 65 cm (deep) water tables indicated that caesium-137, cobalt 60 and cadmium 109 were highly sorbed in shallow lysimeters. Caesium 137 and cobalt 60 appeared to be more mobile than sodium-22 in deep lysimeters, probably due to biological translocation. The soil profile distribution of sodium 22 which was the most physiologically mobile radionuclide differed in the 2 cropping seasons but that of the other radionuclides remained constant. Each radionuclide had a distinct distribution pattern in crop tissue and changes in specific activities indicated major quantitative differences in plant uptake throughout the study period. Cadmium 109 was the most poorly absorbed. Calculated weighted soil to plant transfer factors that accounted for rooting density were lower in the more humid second year and significantly higher for deep than shallow lysimeters in both years. The absorption efficiency of roots near deep water tables appeared to be greater than that of more abundant roots higher in the soil profile (see also preceding abstract). U.K.

95-1643

### **Radium isotopes in suspended matter in an estuarine system in the southwest of Spain**

R. PERIANEZ (Universidad de Sevilla), M. GARCIA LEON and J. M. ABRIL

*Journal of Radioanalytical and Nuclear Chemistry* 1994, 183, No 2, 395-407

Levels of radium 226 and radium 224 in suspended matter from the estuarine system of the Odiel and Tinto rivers in south-west Spain at the vicinity of a phosphate fertilizer complex were determined. The results confirmed the existence of a significant radioactive input from the industrial complex, with up to 2.5 Bq of radium 226 per g of dry weight of suspended matter. Tides and seasonal factors exerted an influence on radium isotopes through changes in salinity. Coefficients for the distribution of radium 226 between the suspended matter and the river water were calculated. The values obtained were broadly in agreement with published values, but depended on tidal and seasonal factors. Spain

95-1644

### **Levels of artificial radionuclides and uranium in rain water collected from Ibaraki (Japan) following the Tomsk-7 accident in Russia.**

Y. MURAMATSU (National Institute of Radiological Sciences, Ibaraki), K. TAGAMI and S. UCHIDA

*Journal of Radioanalytical and Nuclear Chemistry Letters* 1994, 188, No 4, 305-311

Selected radionuclides were measured in rainwater collected in Ibaraki Prefecture, Japan, following the occurrence of an explosion at the Tomsk nuclear complex in the Russian Federation (Siberia) in April 1993. Analytical values were obtained for strontium 90, caesium 137, iodine-131, iodine-129 and uranium-238 in rain samples. The resulting data were compared with values from non-accident

periods and with those from the period following the Chernobyl accident. The Tomsk accident had no appreciable effect on levels of radioactivity in Japan. Since only limited data were available on levels of iodine-129 and uranium in rainwater, the new results contributed to knowledge of background levels. **Japan**

95-1645

# Uranium isotopes in the Hooghly estuary, India.

B. L. K. SOMAYAJULI (Physical Research Laboratory, Ahmedabad)

*Marine Chemistry*, 1994, 47, No 3/4, 291-296

The uranium concentrations in freshwater end member of the Hooghly estuary were 3.9-3.5 µg per litre, higher than in any other estuary so far studied. The uranium-234/uranium-238 activity ratios in the river channel were low (less than 1.10) plus or minus 0.02. In view of the organic pollution, it was estimated that approximately 25 per cent of the uranium entering the estuary in dissolved form is being removed from the estuarine water most likely at the sediment-water interface. **India**

95-1646

# Peroxide variations in the Sargasso sea

W. L. MILLER (Rhode Island University, Narragansett) and D. R. KUSTER

*Marine Chemistry*, 1994, 48, No 1, 17-29

Hydrogen peroxide was determined at depths of 1 m and 3 m over a period of 11 d at an oligotrophic station in the Sargasso sea. The average concentrations of hydrogen peroxide for the first 7 d were 125 nM at 1 m and 110 nM at 3 m but after an evening shower, concentrations rose to an average of 150 nM at 1 m and 135 nM at 3 m for the remainder of the study. Atmospheric input of hydrogen peroxide had a longer term effect on a system reaching equilibrium by a mixing regime and *in situ* processes of generation and decay. The diel distribution of hydrogen peroxide showed a close relationship with vertical density profiles and concentrations fell to less than 5 nM below the thermocline. Hydrogen peroxide could be used as an indicator of freshwater input and ocean mixing processes. There are 46 references. **U.S.A.**

95-1647

# Health Department slammed over sea bathing risks

*INDS Report*, 1994, No 239, 29-31

An inquiry by the House of Lords Select Committee on the European Communities into a proposal to amend the bathing water quality directive concluded that the proposal lacked a proper scientific basis. It also found that the Department of Health unjustifiably rejected scientific evidence that there were significant risks to public health from bathing in water meeting both existing and proposed standards. The committee would publish a further report when it had received a compliance cost assessment. It was impressed by evidence on the effectiveness of ultra violet irradiation of sewage effluent. Other recommendations covered viruses, analysis and inland waters. **U.K.**

95-1648

# Water quality changes in a simulated distribution system

R. M. CLARK (U.S. EPA, Cincinnati, Ohio, U.S.A.), B. W. LYKINS, J. C. BLOCK, L. J. WYMER and D. J. REASONER

*Aqua*, 1994, 43, No 6, 263-277

In a joint study, U.S. EPA and the International Water Research Centre at Nancy (NANCIE) assessed ozone and chlorine for drinking water disinfection and studied distribution system effects at

an experimental pilot facility which had a simulated distribution system. Many complex chemical and microbiological changes occurred simultaneously in the pipe loops. Biofilm buildup increased with residence period in the loop, particularly after disinfectant residual disappeared. Biofilm formation differed depending on the pipe material. Polyethylene pipe sustained the highest buildup. DOC decreased, probably being utilized for biological growth. Decreases in trihalomethane (THM) formation potential were related to the consumption of DOC. In the absence of chlorine, chloral hydrates were converted to THM. **France**

95-1649

# Organic contaminant survey of drinking waters, mineral waters and natural waters in Eastern and Central European countries.

I. KOSTYAL (Helsinki University, Finland), E. SASKI and M. SAIKINOJA-SALONEN

*Aqua*, 1994, 43, No 6, 296-302

Water samples from eastern and central Europe were analysed for organic contaminant parameters: adsorbable organic halogen (AOX), purgeable organic halogen (POX) and nonpurgeable organic carbon. Surface water derived drinking waters were generally high in AOX, with 90 per cent exceeding 50 µg per litre, even though inorganic contaminants were low. The TOC content of drinking water was also higher than in western and northern Europe. AOX contents of mineral waters from the deep wells of the Caucasus mountains ranged from 50-100 µg chlorine per litre. There was no correlation between AOX and TOC contents. Icelandic drinking waters made from river water were very low in AOX (1-2 µg chlorine per litre). **Europe**

95-1650

# A numerical taxonomic study of fluorescent *Pseudomonas* strains isolated from natural mineral waters

M. FLOMARI (Faculté de Médecine, Lille), E. COROIER, D. IZARD and H. FLECHER

*Journal of Applied Bacteriology*, 1995, 78, No 1, 71-81

Forty-six strains of fluorescent pseudomonads, identified according to Palleroni's criteria, were isolated from mineral waters. These, together with 12 strains from clinical material and 44 reference strains, were phenotypically classified by 281 characteristics. Data were processed by the Dice similarity coefficient and unweighted pair algorithm with arithmetic averages. Eight clusters were defined at the 62 per cent similarity level. Clusters I, II and IV divided into 9 subclusters. Virtually all the mineral water strains fell into groups IV, IIa and V, the first 2 were composed exclusively of mineral water strains. Cluster V contained 13 mineral water strains and 3 culture collection strains of *Pseudomonas fluorescens biovar III*. **France**

95-1651

# Water quality assessment and treatment study on existing dispersed groundwater resources in Bihar

L. PRASAD (PHED, Bihar), D. B. CHATTERJEE and C. B. SHARMA

*Journal of Indian Water Works Association*, 1994, 26, No 2, 109-116

Water samples were analysed for chemical and bacterial contents in the Public Health Engineering Department of the Public Health Institute, Bihar, during 1992-93 and the quality criteria indices are listed. Of the samples from north Bihar, contained more 52.12 per cent than the maximal permissible limit of 1 ppm iron and 43.28 per cent contained bacteria causing serious concern. Samples from the

## MONITORING AND ANALYSIS

central Bihar region contained iron (82.4 per cent), fluoride (69.57 per cent) and nitrate (94.79 per cent) within the safe limit. Groundwater reserves of the plateau region of Chotanagpur and Santhal Pargana had pH lower than 6.5 in 32.53 and 55.38 per cent of total analysed water samples, respectively. All groundwater samples in Chotanagpur were free from bacteria. Groundwater had fluoride concentrations greater than 1.5 ppm in 43 samples. **India**

95-1652

**Mutagenic and carcinogenic risk of oxygen containing chlorinated C-3 hydrocarbons: putative secondary products of C-3 chlorohydrocarbons and chlorination of water.**

E. EDER (Wurzburg University), and E. WEINFURTER (*Chemosphere*, 1994, 29, No 9/11, 2455-2466)

The oxidation of chlorohydrocarbons with 3 carbon atoms in air, in pesticide metabolism and chlorination of drinking water yielded mutagenic and carcinogenic carbonyl compounds. Many of these compounds were tested for genotoxicity, mutagenicity and carcinogenicity by the Ames test, induction of the *sfia*-gene linked SOS repair system, saturated and unsaturated 1-N2 cyclic deoxyguanosine adduct methods. Of these compounds, 2 chloroacroleins were extremely strong mutagens and genotoxins and formed 1-N2 cyclic deoxyguanosine adducts. Primary mechanisms underlying mutagenicity and carcinogenicity were considered, the effects being explained by interaction with DNA. Further research on the extent of DNA damage and environmental contamination was required. There are 43 references. **Germany**

95-1653

**No health threat from algal toxins in water, DWI concludes.**

*INDS Report*, 1994, No 239, 8-9

Following a 4 year study of blue-green algal toxins and their occurrence in water supplies, the Drinking Water Inspectorate concluded that there was no evidence of a health risk via tap water supplies even during algal blooms. Toxins were rarely detectable in water supplies. A toxicological assessment of microcystin LR showed mice to be more sensitive than rats but displayed a no observed effect level for tissue damage of about 40 µg per kg body weight. Advanced water treatment processes could remove both microcystin LR and anatoxin-a from drinking water. Filtration with granular activated carbon was very effective at a contact time of 15 minutes. Toxins were removed or degraded by dosing clarified water with oxidizing agent. Potassium permanganate and ozonation were effective. Chlorine disinfection was ineffective except at low pH and ultra violet light achieved only about 30 per cent degradation. **U.K.**

95-1654

**Faecal pollution in river Vaigai.**

N. KRISHNAN (Thiagarajar College, Madurai), A. JEYACHANDRAN, and G. Jeya Kumar

*Indian Journal of Environmental Health*, 1994, 36, No 2, 128-129. The Vaigai river was the primary water supply source for the city of Tamil Nadu. Faecal coliforms and faecal streptococci were present in the river due to human defaecation. A quantitative assessment of the extent of the human defaecation was undertaken. The construction of lavatories along the river banks and the maintenance of existing lavatories could reduce faecal pollution of the river. **India**

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See also Abstracts 95-1544, 95-1620, 95-1650, 95-1777, 95-1794, 95-1795, 95-1796, 95-1976, 95-1983, 95-1985, 95-1991, 95-1995, 95-1997

95-1655

**Assessment of bacteriological water quality using a modified H2S strip test.**

C. VENKOBACHAR (Indian Institute of Technology, Kanpur), D. KUMAR, K. TALREJA, A. KUMAR, and L. JYENGAR (*Aqua*, 1994, 43, No 6, 311-314)

Cystine was added to a hydrogen sulphide strip medium used to screen drinking water for faecal pollution. Using water samples from various natural sources, performance was compared with the original medium and with a conventional bacteriological test. There was a good correlation between all the tests but the addition of cystine improved sensitivity and reduced the analysis time. Quantification of the extent of bacterial pollution could be achieved using 5 bottles. The strip test was used on un piped water sources used by rural communities in India and showed that water drawn by India Mark II hand pumps from wells with an average depth of at least 30 m was the safest. **India**

95-1656

**Poor specificity of m-Endo and m-FC culture media for the enumeration of coliform bacteria in sea water.**

M. J. FIGUERAS (Rovira i Virgili University, Reus), F. POLO, I. INZA, and J. GUARRO

*Letters in Applied Microbiology*, 1994, 19, No 6, 446-450

Traditionally coliform bacteria have been used as indicators of the sanitary quality of bathing and recreational waters. However, there are problems associated with the currently used culture media (m-Endo for total coliforms (TC) and m-FC for the faecal coliforms (FC)) in that false positive and false negative colonies can significantly alter the precision of the results. Thus, the specificity of these media (m-Endo and m-FC) for the detection and enumeration of TC and FC from sea water samples, was evaluated using a high number of strains from a wide sampling region. The usefulness of the recommended biochemical tests, *O* nitrophenyl beta D galactopyranoside (ONPG) and cytochrome oxidase (CO) for the confirmation of the colonies was also evaluated. The high percentages of non-coliforms, 21.9 per cent on m-Endo and 27.7 per cent on m-FC after identification of the presumptive TC and FC isolates to species level, indicated that these media ought not to be considered specific. The ONPG and CO tests were unreliable since they eliminated only approximately 10 per cent of the false positives in both media. A revision of the definition of faecal coliforms is suggested. There are 32 references. **Spain**

95-1657

**False-positive coliform readings using membrane filter techniques for seawater.**

J. HERNANDEZ-LOPEZ (Center for Biological Research, La Paz), and F. VARGAS-ALBORES

*Letters in Applied Microbiology*, 1994, 19, No 6, 483-485

Seawater samples analysed by membrane filtration (MF) techniques for total coliforms (TC) produced false-positive readings. How these false-positives were determined is described and the usefulness of MF-based techniques for seawater was questioned. The culture

media and the incubation temperatures used were responsible for the growth of vibrios which are abundant in seawater. The vibrio colonies isolated by MF were cytochrome oxidase positive Gram negative short rods that grew on TCBS agar (thiosulphate-citrate bile salts sucrose), and required sodium chloride. Discrepancies in results were found by using MF for faecal coliforms (MEFC at 44 °C) and MF7h (at 4 °C) and were due to the incubation temperature which permitted the growth of vibrios. To avoid false positive results for TC and FC in seawater, MF based methods should be avoided. **Mexico**

95-1658

#### Use of fluorochromes for direct enumeration of total bacteria in environmental samples: past and present

R. T. KEPNER (Pennsylvania State University, University Park) and J. R. PRATT

*Microbiological Reviews*, 1994, **58**, No 4, 603-615

Studies involving fluorochrome staining followed by epifluorescent microscopic direct counts for the estimation of total bacterial abundances are reviewed. The 2 fluorochromes most often used in direct count methods were acridine orange (AO) and 4',6-diamidino-2-phenylindole (DAPI). AO and DAPI are reviewed with respect to their usefulness, sample types and historical development. Methods for direct bacterial enumeration are discussed from the point of view of sample preservation, dispersion, membrane filtration techniques, stain concentrations and duration of exposure and investigator bias. Various problems associated with these methods are highlighted including count differences based on choice of stain (between DAPI and AO) and inefficient DAPI staining and particle masking effects. As a starting point toward unifying approaches to performing epifluorescent bacterial direct counts, a generalized procedure is presented which was compatible with several previously recommended methods. There are 97 references. **U.S.A.**

95-1659

#### Comparative study of the behaviour of poliovirus in sterile seawater using RT-PCR and cell culture

J. GUYADER (IFREMER, Nantes), M. L. DINCHER, D. MENARD, L. SCHWARZBROD and M. POMMILLY

*Marine Pollution Bulletin*, 1994, **28**, No 12, 723-726

Survivabilities of Poliovirus 1 were determined in artificial sterile seawater of different salinities (13.9, 24.5 and 33.5 g per litre) by determination of viral RNA by RT polymerase chain reaction (RT-PCR) and by comparison with tissue culture infectivity assay. Salinity had little effect on the behaviour of infectious particles and times required to obtain negative results by cell culture were not statistically different from the salinities studied. Viral RNA was always detected by RT-PCR, indicating persistence of virus particles in a non-infectious form. **France**

95-1660

#### Use of filamentous cyanobacteria for biodegradation of organic pollutants

T. KURITZ (Michigan State University, East Lansing) and C. P. WOLK

*Applied and Environmental Microbiology*, 1995, **61**, No 1, 234-246

The use of cyanobacteria in low cost, low maintenance systems for the remediation of pollutants in surface waters is considered. Because of their being photoautotrophic and, in some cases, able to fix atmospheric nitrogen, the use of cyanobacteria could avoid the need to supply biodegradative heterotrophs with organic nutrients. Two

filamentous cyanobacteria possessed a natural ability to degrade lindane (gamma hexachlorocyclohexane), a highly chlorinated aliphatic pesticide. There was also evidence that this ability could be enhanced by genetic engineering and that these strains could be engineered to degrade 4-chlorobenzoate. There are 42 references. **U.S.A.**

95-1661

#### Bromate reduction by denitrifying bacteria

W. A. M. HJUNEN (Kiwa Research and Consultancy, Nieuwegein), R. VOOGT, H. R. VRIJENDAAL, H. van der JAAG and D. van der KOOIJ

*Applied and Environmental Microbiology*, 1995, **61**, No 1, 239-244

The bacterial reduction of bromate, formed by ozonation in the presence of bromine, was investigated. A mixed bacterial population was able to reduce bromate to bromide following the use of a preceding nitrate reduction step in an anaerobically incubated medium with ethanol as the energy and carbon source at 20 and 25 °C. The dominant species isolated from batch cultures showing bromate reduction were identified as *Pseudomonas* spp. Strains of *Pseudomonas fluorescens* were able to reduce bromate to bromide, though at a much slower rate than the mixed population. The rate of nitrate reduction was at least 100 times lower than that of nitrate reduction. There are 34 references. **Netherlands**

95-1662

#### Reductive dechlorination of Aroclor 1254 by marine sediment cultures

G. D. OLFORD (Washington University, Seattle), L. A. PUHAKKI and E. E. FERGUSON

*Environmental Science & Technology*, 1994, **28**, No 13, 2286-2294

The reductive dechlorination of PCB by marine sediment cultures in the presence and absence of sulphate in sea salt media was investigated. Chitin was the PCB carrier and the principal electron donor. One sulphate amended and one methanogenic culture were incubated at a hydraulic retention time of 50 d. Sodium benzoate, sodium acetate and a mixture of 4 PCB congeners were added to the cultures, slowly increasing the concentrations to 6-9 mg per litre over 17 months. No dehalogenation of the PCB congeners was observed. Two other cultures were batch fed Aroclor 1254 (100 mg per litre) using chitin as electron source and carbon source. Aroclor was dechlorinated both in the presence and absence of sulphate. Reductive dehalogenation of Aroclor 1254 was partial and chlorines were principally removed from *meta* and *para* positions. Dechlorination started after 4 months of incubation. Chitin was mineralized both by marine methanogenic and sulphidogenic microbes. There are 31 references. **U.S.A.**

95-1663

#### In situ biodegradation of toluene in a contaminated stream: 1 field studies

H. KIM (Massachusetts Institute of Technology, Cambridge), H. E. HEMOND, L. R. KRUMHOLTZ and B. A. COHEN

*Environmental Science & Technology*, 1995, **29**, No 1, 108-116

The biodegradation of toluene was determined over a year by mass balance. Sodium chloride was used as tracer to estimate dilution and propane for volatilization; the latter was measured by purge and trap gas chromatography. It was not significantly biodegraded during the experiments. The volatilization rate constant for toluene was obtained from that of propane by the ratios of their diffusivities in water.



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Dilution, volatilization and biodegradation of toluene during the high flows of spring were 25, 34 and 41 per cent of the decrease respectively, the figures during summer low flows were 8, 26 and 66 per cent respectively. These constants were highly dependent on stream temperature but not greatly affected by flow. Removal of toluene by adsorption on to sediments was negligible in this stream. There are 32 references (see also following abstract). U.S.A.

95-1664

### ***In-situ* biodegradation of toluene in a contaminated stream. 2. Laboratory studies.**

B. A. COHEN (Massachusetts Institute of Technology, Cambridge), L. R. KRUMHOLTZ, H. KIM, and H. F. HEMOND. *Environmental Science & Technology* 1995, 29, No 1, 117-125. The rates of degradation of toluene in a contaminated stream were determined in column and batch laboratory experiments and compared with field results previously published. Toluene was measured by headspace analysis; the rate of mineralization was monitored by the fate of carbon-14 labelled toluene. The biodegradation rate constant obtained in batch studies of 0.06-0.16 m per h was comparable with the *in situ* value of 0.08-0.40 m per h from field studies at similar temperatures. The rate constant from column studies was only 2 per cent of the field rate, indicating the superiority of batch measurements. Stream bed surfaces such as sediments and rocks were responsible for more than 95 per cent of compartmental contributions. Batch study rates for winter conditions were 11-14 per cent of those corresponding to summer. Mineralization (conversion to intermediates and assimilation as biomass) accounted for 23, 15 and 62 per cent of the total biodegradation. Biodegradation was the most important environmental sink of toluene (see also preceding abstract). U.S.A.

95-1665

### **Avoidance behaviour test as an alternative to acute toxicity test.**

K. KONDAIAH (B.P.S. & Jr. College, Sampakkudi) and A. S. MURTY. *Bulletin of Environmental Contamination and Toxicology* 1994, 53, No 6, 836-843.

Specimens of 9 species of fish were collected from a canal or natural water bodies in south India. The 96 h LC<sub>50</sub> of phenol was determined for each species. The avoidance of a range of phenol concentrations by fish of each species was studied by measuring the amount of time a fish spent in each half of a tube receiving water at one end and phenol solution at the other. *Oryzias latipes*, *Esomus daniconius* and *Gambusia affinis* were the species which best met the criteria for test species, and showed an avoidance response to a phenol concentration that was not significantly different from the 96 h LC<sub>50</sub>. The avoidance behaviour test was quicker and used fewer fish than the acute toxicity test. India.

95-1666

### **A guideline supplement for determining the aquatic toxicity of poorly water-soluble complex mixtures using water-accommodated fractions.**

A. L. GIRLING (Shell Research Limited, Sittingbourne, U.K.), G. F. WHALE, and D. M. MADEN. *Chemosphere* 1994, 29, No 13, 2645-2649.

It is proposed that toxicity testing for poorly water-soluble complex mixtures should be carried out on water-accommodated fractions which are equilibrium mixtures of water with dissolved and stably dispersed components of the complex. Tests should be carried out

on a range of loading rates (ratios of the test complex to water) which must be individually prepared and not serially diluted. It is necessary to test that an equilibrium has been reached. It is suggested that effective or lethal loading (EL<sub>50</sub> or LL<sub>50</sub>) should be the terms used to express results rather than EC<sub>50</sub> or LC<sub>50</sub>. These tests would provide useful data where only the amount of complex split and the receiving volume are known. Europe.

95-1667

### **Cyst-based toxicity tests X: comparison of the sensitivity of the acute *Daphnia magna* test and two crustacean micro-biotests for chemicals and wastes.**

G. PERSOONE (Ghent University), C. JANSSEN, and W. de COEN. *Chemosphere* 1994, 29, No 12, 2701-2710. Data obtained from published reports of acute toxicity tests on *Daphnia magna* were compared with those using the Streptococcus and Thamnocephalus which are based on cysts from *Sireptococcus proboscideus* and *Thamnocephalus platyurus* respectively. The effects compared were the 24 h EC<sub>50</sub> for the *D. magna* tests and the 24 h LC<sub>50</sub> for the crustacean micro-biotests. Regression analysis of data pairs produced statistically significant correlation coefficients ranging from 0.843 for solid wastes and monitoring wells to 0.95 for pharmaceutical plant effluents. For 72 per cent of cases the effects ratios for the *D. magna* and crustacean tests was less than 4. The new micro-biotests could be used as low-cost alternatives to the *D. magna* acute test. Belgium.

95-1668

### **Trophic-level differences in the bioconcentration of chemicals: implications in assessing environmental biomagnification.**

G. A. LEBLANC (North Carolina State University, Raleigh). *Environmental Science & Technology* 1995, 29, No 1, 153-160. The bioconcentration of xenobiotic chemicals by organisms from abiotic solutions and biomagnification in higher trophic level through the food chain are discussed as reasons for elevated concentrations of such substances in higher organisms. Data for various organohalogen compounds showed that direct uptake from water was much greater for fish than for invertebrates, which in turn exhibited a greater uptake than plankton. A general equation was formulated relating the bioconcentration factor (BCF) at a low trophic level with that at a higher level divided by the chemical lipophilicity. Higher organisms, which invariably had a higher lipid content, naturally accumulated hydrophobic xenobiotics most. It appeared that biomagnification was not very significant in many cases and probably did not occur below a BCF of 114,000. There are 52 references. U.S.A.

95-1669

### **Biomonitoring of water quality using benthic communities in Blanca bay (Argentina).**

R. ELIAS (Universidad Nacional de Mar del Plata) and C. S. BREMEY. *Science of the Total Environment* 1994, 158, 45-49. The effects of pollution by sewage, heavy metals, pesticides and cooling waters on the composition and spatial distribution of benthic communities in Blanca bay, Argentina, are summarized. Commercial fish species that fed on benthos had high metal concentrations in 2 cases near the legal limit for human consumption. Mercury was a particular problem. The benthic and bacterial communities were influenced by the enrichment of organic matter in sediments in the inner bay. A pollution control programme was needed. Argentina.

95-1670

**Persistent chlorinated cyclodiene compounds in ringed seal blubber, polar bear fat, and human plasma from northern Quebec, Canada: identification and concentrations of photoheptachlor.**

J. ZHU<sup>1</sup> (Carleton University, Ottawa, Ont.), R. J. NORSTROM, D. C. G. MUIR, L. A. FERRON, J. P. WEBER and F. DEWAILLY

*Environmental Science & Technology*, 1995, 29, No 1, 267-271. Biological samples were analysed by gas chromatography/ultraviolet and sometimes with mass spectrometry for chlordane compounds, especially heptachlor and photoheptachlor. The latter arose through UV irradiation of heptachlor and was a particularly bioaccumulative toxic compound. It was synthesized from heptachlor to provide calibration standards. Concentrations of photoheptachlor in seal blubber, bear fat and human plasma were 15, 145 and 11 ng per g, respectively. For total chlordane and total PCB, the amounts in the above orders were 706, 4287 and 840 and 762, 10,293 and 6819 ng per g, respectively. Photoheptachlor was not usually detectable in Arctic char and cod, but it was a potentially significant contaminant because of its ability to biomagnify and its high toxicity. (Canada)

95-1671

**Experimentally determined blood and water flow limitations for uptake of hydrophobic compounds using perfused gills of rainbow trout (*Oncorhynchus mykiss*): allometric applications.** D. T. H. M. SIJM (Utrecht University), M. E. VERBERNE, P. J. ART and A. OPPERHUIZEN

*Aquatic Toxicology*, 1994, 30, No 4, 325-341. The influence of water flow (0.045-10 litres per minute/kg) and blood flow (4.4-20 ml per minute/kg) on the uptake of hydrophobic compounds was investigated using perfused gills of rainbow trout (*Oncorhynchus mykiss*). The test chemicals were 1,2,3,4-tetrachlorobenzene, 1,2,3,5-tetrachlorobenzene, pentachlorobenzene, hexachlorobenzene, and 2,2',5,5'-tetrachlorobiphenyl. For all compounds studied, the uptake rate constants increased with water flow between 0.045 and 0.52 litres per minute/kg and remained constant at higher flows. The uptake rate constants remained unchanged when blood flow decreased from 10 to 4.4 ml per minute/kg, but doubled when blood flow was increased from 10 to 20 ml per minute/kg. Allometric relations showed that water flow would limit the uptake of hydrophobic chemicals for fish weighing more than 5 g. An increase in blood flow might increase the uptake of hydrophobic chemical 2-fold in both small and large fish. There are 44 references. (Netherlands)

95-1672

**Comparison of metal concentrations in the fore and hindguts of the crayfish *Cambarus bartoni* and *Orconectes varilis* and implications regarding metal absorption efficiencies.**

T. T. BENDELL, YOUNG (Simon Fraser University, Burnaby, B.C.)

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 6, 844-851.

Crayfish were collected from 4 lakes. Their foreguts and hindguts were removed and the gut contents were analysed for 8 trace metals. For zinc and cadmium, foregut concentrations were lower than hindgut, showing that they were being actively excreted, and for copper, manganese and magnesium they were approximately equal. For calcium, foregut concentrations were higher than hindgut because crayfish have a high metabolic demand for calcium. Crayfish from 2 stressed lakes had higher iron and aluminum concentrations

in their hindguts than foreguts, but those from 2 reference lakes had similar foregut and hindgut concentrations. (Canada)

95-1673

**Chlorinated contaminants in chorio-allantoic membranes from great blue heron eggs at Whidbey Island naval air station.**

G. P. COBB (Clemson University, Pendleton, SC), D. M. NORMAN, M. W. MILLER, I. W. BRIWER and R. A. JOHNSTON

*Chemosphere*, 1995, 30, No 1, 151-164.

Eggshells of the blue heron (*Ardea herodias*) with chorio-allantoic membranes (CAM) remaining were collected on a single day. The CAMs were removed, homogenized, extracted, the determinands concentrated on a C-18 SPE column, eluted and separated further before analysis by gas chromatography. Data were examined by analysis of variance techniques. Concentrations of DDT, DDE, DDD, Aroclor 1254 and Aroclor 1260 were below 0.4 ppm for 13 of 14 samples. The low correlation of DDT and its metabolites in CAM suggested that herons were not being exposed to a consistent source of the compounds or that exposed herons had recently jointed the colony. (U.S.A.)

95-1674

**8-Year study on the elimination of PCBs and other organochlorine compounds from eel (*Anguilla anguilla*) under natural conditions.**

J. de BOER (Netherlands Institute for Fisheries Research, IJmuiden), J. van der VALK, M. A. T. KIRKHOFF, P. HAGEL and U. A. BRINKMAN

*Environmental Science & Technology*, 1994, 28, No 13, 2242-2248.

Yellow eels (*Anguilla anguilla*) containing high concentrations of PCB, chlorobenzenes, and octachlorostyrene were transferred from the Rhine river in The Netherlands to Milligensteeg lake, a relatively clean lake, to study elimination of the organochlorine compounds. The eels were sampled after 4 months and at periods up to 8 years after transfer. Pentachlorobenzenes, hexachlorobenzene, and octachlorostyrene had elimination half-lives of 340, 1450 d under natural conditions. Elimination rate constants for these compounds under natural conditions were more than a magnitude smaller than those obtained in laboratory experiments. For the hexa-, hepta-, and octachlorobenzenes there was generally no elimination. There are 39 references. (U.S.A.)

95-1675

**Studies on heavy metal pollution in the finfish, *Oreochromis mossambicus* from river Cauvery.**

K. AYYADURAI (Tamil Nadu Veterinary and Animal Sciences University, Madras), C. S. SWAMINATHAN and V. KRISHNASAMY

*Indian Journal of Environmental Health*, 1994, 36, No 2, 99-103.

A quantitative assessment was made of heavy metals in Cauvery river water and in the muscle, gill, liver and viscera of fish. Water concentrations were below Indian Standards Institution/World Health Organization and U.S. EPA permissible limits. Mean concentrations in water were 0.001, 0.126, 0.007 and 0.006 mg per litre for copper, lead, manganese and zinc, respectively, and in fish muscle were 1.28, 6.30, 0.86 and 6.36 mg per kg. Mean mercury concentration was 0.065 mg per kg in fish muscle but it was below the detectable limit in water. In fish organs, greatest metal accumulation was in the liver followed by viscera then gill. (India)

## MONITORING AND ANALYSIS

95-1676

**Use of zinc-65 as a radioactive tracer in the bioaccumulation study of zinc by *Poecilia reticulata***

W. MALAGRINO (Comissao Nacional de Energia Nuclear, Sao Paulo) and B. MAZZILLI

*Journal of Radioanalytical and Nuclear Chemistry* 1994, 183, No 2, 389-393

The absorption and elimination of zinc by *Poecilia reticulata* was investigated using water and food contaminated with the radioactive tracer zinc-65. Two series of experiments were undertaken to quantify the absorption experiments lasted 18 d while the elimination experiments lasted 40 d. Thirty days were needed for the elimination of 70 per cent of zinc previously absorbed from water. In the case of fish fed with food contaminated with zinc-65 only 40 per cent of the absorbed zinc was eliminated in 40 d. The results were significant with respect to the contamination of the food chain in the Sao Paulo urban area where zinc was a major pollutant. **Brazil**

95-1677

**PCBs and other chlorinated organic contaminants in tissues of juvenile Kemp's ridley turtles (*Lepidochelys kempi*)**

J. I. LAKE (U.S. EPA, Narragansett, RI), R. HAEBLER, R. MCKINNEY, C. A. LAKE and S. S. SAHOO

*Marine Environmental Research* 1994, 38, No 4, 313-327

Sea turtles (*Lepidochelys kempi*) killed by seasonal low temperature were collected from the eastern shores of Long Island between 1980 and 1989 and concentrations measured of PCB and chlorinated pesticides in liver and body fat. PCB concentrations varied between 655 ng per g in 1980 to 272 ng per g in 1989 in liver samples and 1250 ng per g in 1980 to 476 ng per g in 1989 in body fat. Average liver concentrations were 4 to 10 times higher than in livers of other sea turtles. The highest PCB concentration found was 20 times less than that causing reproductive effects in the freshwater turtle *Chelydra serpentina*. Average annual concentrations of *p,p'*-DDE and *trans*-nonachlor were 137 to 386 ng per g and 27.5 to 129 ng per g. Concentrations of PCB, *p,p'*-DDE and *trans*-nonachlor were strongly correlated and suggested that either tissue could be used to monitor the contaminants. **U.S.A.**

95-1678

**Mercury concentrations in stomach contents and muscle of five fish species from the north east coast of England**

R. DIXON (Newcastle University) and B. JONES

*Marine Pollution Bulletin* 1994, 28, No 12, 741-745

Herring (*Clupea harengus*), whiting (*Merlangius merlangus*), roker (*Raja clavata*), plaice (*Pleuronectes platessa*) and dab (*Limanda limanda*) were collected during the summer of 1992 at the mouth of the Tyne river and mercury concentrations in the stomach contents and muscle tissue were determined. Median muscle mercury concentrations increased in the order plaice, herring, roker, dab and whiting. Absolute mercury concentrations and the relationship between muscle mercury and fish length indicated the low environmental availability of mercury. Median stomach mercury contents increased in the order plaice, roker, dab. The variability of the ratio of muscle mercury to stomach content mercury was low for dab (39.7 per cent) whereas it was higher for plaice (128.4) and roker (184.6) per cent respectively. If stomach content mercury concentrations accurately reflect local mercury availability, then dab muscle tissue would make a more reliable availability index than muscle tissue of plaice or roker. **U.K.**

95-1679

**Epiphyte size and taxonomy as biological indicators of ecological and toxicological factors in lake Saint-Francois (Quebec)**

A. CATTANEO (Universite de Montreal, P.Q.), G. METHOT, B. PINEL, ALLOU, T. NIYONSENGA and L. LAPIERRE

*Environmental Pollution* 1995, 87, No 3, 367-372

Community descriptions and biotic indices based on size structure and taxonomic composition were compared to evaluate the response of epiphytes to environmental factors. The relative contributions of ecological and toxicological variables in explaining variations in epiphytes were quantified. Sites classified by size were similar to those classified by taxonomy, but a larger portion of the variance in the former could be explained, indicating a stronger relationship with environmental factors. For both size based and taxonomy based biotic indices, the slope of the normalized size spectra performed best in terms of total explained variance. There were strong interactions between toxicological and ecological variables which should be considered in planning and interpreting biomonitoring studies to which samples should be taken from sites with similar ecological characteristics. There are 74 references. **Canada**

95-1680

**Bioaccumulation of metals by *Hyaella azteca* exposed to contaminated sediments from the upper Clark Fork river, Montana**

C. G. INGERSOLL (Midwest Science Center, Columbia, Mo.), W. G. BRUMBAUGH, F. J. DWYER and N. E. KEMBLI

*Environmental Toxicology and Chemistry* 1994, 13, No 12, 2015-2020

Sediments in the upper Clark Fork river, Mont., U.S.A. were heavily contaminated with arsenic, cadmium, copper, lead, manganese, and zinc. Fish in the river depended on a food source of macroinvertebrates and the metals associated with this food source might present a potential hazard to the fish. The bioaccumulation of arsenic, cadmium, copper, lead, and zinc was evaluated by exposing mature *Hyaella azteca* for 28 d in the laboratory to sediment samples collected from depositional areas in the Clark Fork river. Benthic invertebrates collected from riffles adjacent to each depositional area were also analysed for metals. The concentrations of metals in laboratory exposed amphipods were often 50-75 per cent less than those of field collected invertebrates, indicating that sediment was a significant source of metals to invertebrates in the river. The implications of the results for fisheries in the area are discussed. There are 37 references. **U.S.A.**

95-1681

**Trace metal concentrations in common benthic macrofaunal prey from the New York Bight apex**

J. W. STELMLE (U.S. Department of Commerce, Highlands, N.J.), V. S. ZDANOWICZ, S. E. CUNNEE and R. TERRANOVA

*Marine Pollution Bulletin* 1994, 28, No 12, 760-765

Concentrations of mercury, cadmium, chromium, copper, nickel, lead, zinc, silver, tin, arsenic and selenium were determined in common benthic prey to evaluate the potential for transfer of metals from prey to higher trophic levels. Benthic prey were collected between 1983 and 1985 from 7 areas in the Bight apex spanning a range of habitat quality conditions and from a reference site. Benthic taxa were selected because of their common use as prey for fish and American lobster. Data for 14 species, mixed polychaetes and amphipods are tabulated. Metals concentrations in prey from areas adjacent to a former sewage sludge disposal site were higher than in prey from other areas, implying that prey from this site could be an

important source of toxic metals to benthic feeding finfish and foraging lobsters. There are 37 references. U.S.A.

95-1682

**Effect of temperature on the uptake of copper by the brine shrimp, *Artemia franciscana*.**

R. BLUST (Antwerp University) L. van GINNEKEN and W. DECLER

*Aquatic Toxicology* 1994, 30, No 4, 343-356

The effect of temperature (10-35°C) on the uptake of copper by the brine shrimp (*Artemia franciscana*) was studied in chemically defined saltwater solutions. The shrimps were acclimated to solutions of differing temperatures over a 5-d period and then kept at the final temperature for 10 d. They were then transferred for 1 h to a saltwater solution containing 1 mM 8-hydroxyquinoline 5-sulphonic acid to remove metal bound to the external surfaces of the shrimp. Copper uptake increased with increasing temperature of exposure and decreased with the temperature of acclimation. Copper speciation changed with changing temperature. The effect of these different processes on the free cupric ion activity was calculated using the chemical speciation model SOLUTION. The magnitude of the apparent activation energy for copper uptake indicated that it is a facilitated diffusion process. Over the temperature range 10-35°C the diffusional flux of the cupric ion in the solution increased from 10.6 to 0.147 pmol per cm<sup>2</sup> second. There are 39 references.

Belgium

95-1683

**PCB and metal concentrations in American lobsters from the Acushnet river estuary and Long Island Sound**

R. MERCALDO ALLEN (National Oceanic and Atmospheric Administration, Milford Conn.) C. A. KUROPATRA, C. RIEG and G. SENNIFELDER

*Bulletin of Environmental Contamination and Toxicology* 1994, 53, No 6, 820-827

Egg-bearing American lobster (*Homarus americanus*) were taken from New Bedford harbour and Long Island Sound. Embryos, first stage and postlarvae or juveniles were sampled from each female and analysed for PCB and metals. PCB were found at high concentrations in embryos and offspring of New Bedford harbour lobsters, with the highest concentrations in embryos (11.2 µg per g wet weight). Lower concentrations were found in Long Island Sound samples. Copper concentrations in Long Island Sound samples ranged from 172-227 µg per g dry weight for embryos from different sites, and 25-28 µg per g in juveniles. The mean concentrations of other metals found in Long Island Sound samples of all growth stages were below 0.66, 4.12 and 6.09 µg per g dry weight for cadmium, lead and chromium, respectively. U.S.A.

95-1684

**Trace metals in the Mexican shrimp *Penaeus vannamei* from estuarine and marine environments**

F. PAEZ-OSUNA (Universidad Nacional Autonoma de Mexico, Sinaloa) and C. RUIZ FERNANDEZ

*Environmental Pollution* 1995, 87, No 2, 243-247

Iron, manganese, nickel, copper, cobalt, cadmium, chromium and zinc were measured in estuarine postlarvae, juveniles and marine adults of *Penaeus vannamei* collected from 4 sites along the Pacific coast of Mexico. All metals except for iron showed similar concentrations to those found in shrimps collected from other sites. Nickel, iron and zinc showed size dependent relationships which varied according to the metal. Small individuals had higher concentrations

of iron and nickel than larger individuals whereas the opposite trend occurred for zinc. This was attributed to different metabolic requirements of young and old shrimps. Mexico

95-1685

**Levels and long-term trends of polychlorinated biphenyls and DDTs in bivalves collected from the south Adriatic coastal waters.**

M. PICER (Rudjer Boskovic Institute, Zagreb) and N. PICER

*Chemosphere* 1995, 30, No 1, 31-38

The soft tissues of bivalves collected during 1976-1990 at several Adriatic coastal stations were homogenized, extracted, cleaned up and analysed by gas chromatography. Analytical results were corrected following international inter-laboratory collaborative exercises. Total DDT and PCB mass fractions were not normally distributed so logarithms of the data were used. Mass fractions depended on the collection area, period and seasons. PCB were at higher levels in spring and autumn compared with other seasons. Total DDT concentrations declined with time but the trend for PCB was less clear. Croatia

95-1686

**A comparative study on environmental radioactivity in shellfish inhabiting the coasts of Korea and Japan**

Y. K. OH (Cheju National University, Korea)

*Journal of Radioanalytical and Nuclear Chemistry Letters* 1994, 188, No 5, 313-321

Samples of sea mussels, *Mytilus coruscus* and *Mytilus edulis* collected from 4 different sites of nuclear power plants (Kori, Ulchin, Wolsong and Younggwang) and Cheju do as a control site, were measured for gross beta radioactivity and gamma spectrometry. To determine radionuclide contents in the samples, gamma ray spectrometry was conducted on the dried samples using a germanium detector. A part of the dried sample was carbonized (heated at 650°C for 23 h) in an electric oven and used for the beta ray counting. The gross beta radioactivity was similar to that in nature. Among radionuclides, only caesium-137, potassium-20, beryllium-7 and cobalt-60 were detected in very small amounts. No other manmade radionuclides were detected. Far East

95-1687

**Evaluation of free amino acids as a biochemical indicator of metal pollution**

H. H. MMEJ (Centre for Estuarine and Coastal Ecology, Yerseke, Netherlands), R. BOGAARDS, J. de WOLF, J. SINKE and T. POORTVLIET

*Marine Environmental Research* 1994, 38, No 4, 303-312

Mussels (*Mytilus edulis*) were collected from 7 locations in the Taff estuary, Cornwall, during September 1989 and extracts analysed for free amino acids (FAA) by HPLC to determine a biochemical stress index (SI) for metal pollution. Copper affected the amount and composition of FAA whereas salinity and zinc had little effect. The serine plus threonine sum as an SI was questioned. The leucine:glycine ratio (TGR) could only be used at copper concentrations greater than 20 µg per litre. At lower concentrations TGR did not show a relationship with copper concentration whereas at higher concentrations, the mussels died. U.K.

## MONITORING AND ANALYSIS

95-1688

### Chlorinated organic compounds, PAHs, and heavy metals in sediments and aquatic mosses of two upper Austrian rivers.

A. CHOVANEC (Federal Environmental Agency, Vienna), W. R. VOGEL, G. LORBEER, A. HANUSCHENAR, and P. SEIF.

*Chemosphere*, 1994, 29, No 9/11, 2117-2133.  
Sediments and aquatic moss, *Fontinalis antipyretica*, were taken from 4 sampling points on the Danube and Traun rivers near Linz. No moss was available at the Danube sampling point upstream of the city. The samples were extracted, cleaned up and fractionated on several columns before analysis by various chromatographic techniques for chlorinated hydrocarbons, chlorophenols, and PAH. Heavy metals were analysed on separate samples. Generally samples were not highly contaminated compared with results reported for other areas affected by industry. Metal levels were similar in sediments and mosses with the exception of mercury which was higher in the latter. Most PAH, heavy metals except mercury, gamma hexachlorocyclohexane (HCH), PCB 138, 153 and 180 were detected in sediments and mosses. Hexachlorobenzene, delta HCH, epsilon HCH and some PCB were found only in mosses, suggesting their usefulness as monitoring organisms. There are 46 references. Austria.

95-1689

### Use of freshwater plants for phytotoxicity testing: a review.

M. A. LEWIS (U.S. EPA, Gulf Breeze, Fla.)

*Environmental Pollution*, 1995, 87, No 3, 319-336.

The use of freshwater plants in toxicity tests and the usefulness of data derived from such tests are discussed. Methodology, nutrient media, test species, test duration, light, temperature, pH, calculations of toxicity and utility of data are considered with reference to studies using algae. Studies using duckweed and other vascular plants are also considered. The effects of bioaccumulation, effluents, contaminated sediment, and hazardous wastes are briefly considered and phytotoxicity summaries are identified. There are 214 references. U.S.A.

95-1690

### Trace metal concentration in vegetative parts of *Ipomea pes-caprae*.

A. MITRA (Calcutta Port Trust, Midnapore, West Bengal), A. CHOUDHURY, and D. BASU.

*Indian Journal of Environmental Health*, 1994, 36, No 2, 119-123.  
The Hooghly Matla estuarine complex received sewage and effluents from Calcutta, Howrah and Haldia. Seasonal fluctuation of metal contamination was studied by analysing the magnitude of metal accumulation in the sandbinder *Ipomea pes-caprae*. The plants used were from different locations which had contrasting physico-chemical characteristics. Ion concentrations were high. Metals were accumulated in the order iron, zinc, manganese, copper, nickel, cobalt and lead. Greatest metal accumulation was in the root region followed by stem and leaf. Plants from all locations showed a unique seasonal behaviour with high metal concentrations during the monsoon period. This could be due to monsoonal runoff from the adjacent cities. The plants might be suitable for use in the biological treatment of industrial effluent. India.

95-1691

### A survey of some trace elements in seaweeds from Patagonia, Argentina.

J. O. MUSE (Universidad de Buenos Aires), M. B. TUDINO, L. J. HUICQUE, O. E. TROCCOLI, and C. N. CARDUCCI.

*Environmental Pollution*, 1995, 87, No 2, 249-253.

Cadmium and lead concentrations were measured in representatives of the genera *Adenocystis*, *Colpomenia*, *Leathesia* in the brown kelps *Macrocystis pyrifera* and *Lessonia furcescens*, and the red algae *Gigartina skottsbergii* collected from Neuquén gulf and Camarones bay. Lead and cadmium were present in all samples examined and in other brown algae collected from the industrial site at Neuquén gulf. High concentrations of aluminium (300-3000 mg per kg) were also found in the gulf samples, the highest in *Colpomenia sinuosa*. Concentrations of cadmium and lead were lower than previously reported for the same species from other locations. Argentina.

95-1692

### Assessment of bioavailability of heavy metals using *lux* modified constructs of *Pseudomonas fluorescens*.

G. I. PATON (Macaulay Land Use Research Institute, Aberdeen), C. D. CAMPBELL, L. A. GLOVER, and K. KILHAM.

*Letters in Applied Microbiology*, 1995, 20, No 1, 52-56.

The effect of potentially toxic elements on the bioluminescence of *lux* modified *Pseudomonas fluorescens* was examined using an *in vitro* assay. Bioluminescent response was evaluated for both plasmid and chromosomally encoded *lux* genes. The cells were added to a range of metal salt concentrations. In a general decline in bioluminescent response was observed for increasing metal concentrations, with the plasmid construct significantly more sensitive to all metals apart from chromium. Element sensitivity was general for copper and zinc for each construct and declined in the order cadmium, chromium, nickel for the chromosomal modification and in the order cadmium, nickel, chromium for the plasmid modification. The sensitivity of *lux* made a *P. fluorescens* to potentially toxic elements suggested a possible assay method for the assessment of pollution in fresh water and soil. U.K.

95-1693

### Suspended sand measurements in a turbulent environment: field comparison of optical and pump sampling techniques.

K. P. BLACK (Victorian Institute of Marine Sciences, Melbourne) and M. A. ROSENBERG.

*Coastal Engineering*, 1994, 24, No 1/2, 137-150.

Suspended sediment concentrations in and near the surf zone were measured from a movable platform on an ocean beach at Apollo Bay, Vic. Values from pumped samples were compared with measurements from an optical backscatter sensor. At higher values of eddy diffusivity and sediment grain size under breaking waves, the efficiency of pump trapping of suspended sediment increased by up to a factor of 2.1. This was attributed to the turbulent diffusion or convection of sediment particles in directions parallel to the pump inlet. Further offshore, the pump undersampled the suspended sediment. The response of optical backscatter sensors depended on the suspended sediment grain size. Australia.

## AQUALINE ABSTRACTS Vol.11 No.4

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95-1694

**New sampling devices for environmental characterization of groundwater and dissolved gas chemistry (CH<sub>4</sub>, N<sub>2</sub>, He).**  
B. SHERWOOD LOLLAR (Waterloo University Ont.) S. K. FRAPE and S. M. WEISE

*Environmental Science & Technology* 1994, 28, No 13, 2423-2427

Sampling devices were developed which were narrow-diameter (3.18 cm) self-contained units, capable of withstanding external pressures of up to 10,000 KPa and of operating in freshwater and saline waters. The devices were developed to provide geochemical and isotopic data on dissolved gas and groundwater chemistries using existing boreholes drilled for mineral exploration. Results of field tests designed to characterize the environmental chemistry of groundwaters at sites on the Fennoscandian Shield of Finland are presented. **Canada**

95-1695

**Impact of river transport characteristics on contaminant sampling error and design.**

I. G. DROPPO (National Water Research Institute, Burlington Ont.) and C. JASKOT

*Environmental Science & Technology* 1995, 29, No 1, 161-170

The effect of a river's variable transport characteristics on the design of a sampling programme for estimating contaminant load was investigated in a river of 25 m cross-section and less than 1 m depth at base flow. Mean annual discharge was 16 m<sup>3</sup> per second with a range of 2-230 m<sup>3</sup> per second. Single vertical depth integrated samples were taken at the centroid of the flow of 5 equal discharge intervals in the river cross-section. Hourly or 4 hourly samples were collected automatically during storms. Dewatered sediment samples were obtained on site by pumping large volumes of river water through a continuous centrifuge. Five river transport characteristics were examined: contaminant transport modes, whether dissolved, suspended solids or bed load; short-term temporal and seasonal variability; the relationship between dissolved and particulate contaminant concentrations and discharge; load distribution with sediment particle size; and spatial variability in a cross-section. Their effects were site-specific. For the river investigated, the fine-grained sediment and the randomness of the cross-section variation enabled net load to be obtained by a single vertical with multiple samples, a composite sampler, and a continuous centrifuge for particles. **Canada**

95-1696

**What about quality assurance before the laboratory analysis?**

K. J. M. KRAMER (TNO Institute of Environmental Sciences, Den Helder)

*Marine Pollution Bulletin* 1994, 29, No 4/5, 222-227

The importance of how samples are handled before they enter the laboratory is emphasized. All aspects of sampling including location, frequency, the skill of the staff, the type of container and where appropriate, means of filtration and centrifugation are considered. Preservation, transport, storage, contamination control and adequate documentation are discussed. All these factors could nullify accurate chemical analysis if neglected. They required quality assurance procedures and good measurement practices to ensure the reliability of the whole process of sampling and analysis. There are 39 references. **Netherlands**

95-1697

**Measuring techniques for effluent discharges, with regard to on-line instruments**

P. RAUMANN (Universität Stuttgart)

*Abwasser-technik* 1994, 45, No 6, 52-54 (in German)

The possibility of using on-line measuring equipment in place of the current methods based on 2 h or 24 h combined spot samples for assessing compliance with effluent quality controls is reviewed. The present system was enshrined in the pollution control legislation, but the results obtained were subject to random variation and might not accurately reflect the overall picture regarding the magnitude of the pollution load entering the receiving stream. The extent to which on-line measuring equipment for a variety of analytical parameters had already been adopted by sewage plant operators, principally for process control functions, is reviewed and the prospects for their wider application in the context of pollution control legislation are assessed. In the short term, the reliance on spot sampling would persist, but further refinements in equipment and in the system of official supervision should permit the use of continuous on-line effluent quality monitoring in the longer term. (English translation 105 pounds sterling valid for 1995). **Germany**

95-1698

**Regional-scale ground water quality monitoring via integer programming**

P. I. HUDAK (North Texas University, Denton), H. A. LOALICGA and M. A. MARINO

*Journal of Hydrology* 1995, 164, No 1/4, 153-170

Monitoring sites in multilayered regional groundwater flow systems at risk from contamination by leachates from waste storage facilities were identified using a network design approach. Weights were assigned to candidate locations to quantify monitoring value in terms of the prospect of plume detection and exposure hazard criteria. Monitoring locations were selected by incorporating the weights in a binary integer mathematical programming problem. The network design model was assessed against a 100 point composite plume detection and characterization efficiency scale. It scored 87, compared with a score of 76 for an existing monitoring network with the same number of wells. The model selected well sites which were close together near the source of contamination. **U.S.A.**

95-1699

**Biological test methods for effluent monitoring**

I. HAHN (Institut für Wasser-, Boden- und Lufthygiene, Berlin)

*Korrespondenz-Abwasser* 1994, 41, No 12, 2279-2280 and 2283-2284 (in German, English summary)

The application of bioassays to monitor the ecotoxicological effects of effluent discharges is discussed in general terms. The methods avoided the necessity for a detailed knowledge of the composition of the sample, and provided a reliable indication of the end result of a given discharge, such as the possibility of fish kills or growth inhibition in the case of micro-organisms and lower forms of plants and animals. Selection of the test organism was dependent on the trophic level of principal concern, and 4 different tests are proposed as representative of those involved in natural ecosystems, namely golden orfe, daphnia, algae (*Scenedesmus subspicatus*) and luminescent bacteria (*Photobacterium*). These were definitive methods based on DIN standards, the results being generally recognized as authentic and valid in court as a basis for legal enforcement measures. Some additional tests indicative of the degree of biodegradability of organic constituents of effluent samples are also considered as a means

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of providing a comprehensive indication of effluent quality (English translation 140 pounds sterling valid for 1995) **Germany**

**95-1700**

**Continuous and early detection of toxicity in industrial wastewater using an on-line respiration meter.**

C. W. KIM (Pusan National University, Keumjungku Pusan), B. G. KIM, T. H. LEE, and T. J. PARK

*Water Science & Technology*, 1994, **30**, No 3, 11-19

An on-line toxic detection system for the early and continuous observation of toxicity in the wastewater treatment plant of a petrochemical company which produced phthalic acid is described. The plant treated the wastewater using an extended activated sludge process. During annual shut-down the reactors were cleaned with sodium hydroxide which could possibly reach the biological reactor. The toxicity detector consisted of a contact chamber and an on-line respiration meter. The operation of the on-line detection system and continuous toxicity tests are described. The relationship between organic loading rate and actual respiration rate was studied. A ratio of influent sample flow to activated sludge flow of more than 0.6 was recommended to obtain maximal respiration rate. The system was tested under conditions of high and low pH, cobalt inhibition, and the addition of catalyst wastes. **Korea**

**95-1701**

**Principal component analysis in the evaluation of environmental data.**

V. ZITKO (Department of Fisheries and Oceans, St. Andrews, N.B.)

*Marine Pollution Bulletin*, 1994, **28**, No 12, 718-722

Using published data, the usefulness was demonstrated of Principal Component Analysis (PCA) in the examination of multivariate data. The incorporation of PCA into laboratory information management systems (LIMS) at the data conversion stage is suggested. The use of PCA in data evaluation is discussed using as examples studies of enzyme induction and contaminants, heavy metals in sediments and mussels, metals in sediments and corals, and organochlorine compounds in fish. **Canada**

**95-1702**

**QUASIMEME, quality assurance of information for marine environmental monitoring in Europe.**

D. I. WELLS (SOAFD Marine Laboratory, Aberdeen)

*Marine Pollution Bulletin*, 1994, **29**, No 4/5, 143-145

The background and objectives of the QUASIMEME programme are explained. It sought to improve the quality of chemical information among marine institutes. A questionnaire revealed training, guidelines on sampling and sample storage, and the availability of reference materials as key needs. This resulted in inter-laboratory comparison studies, judged by Z-scores, on nutrients in sea water, trace metals in sediments, and PCB in fish oils. Workshops had reviewed the results and helped individual laboratories improve their quality assurance. The project was continuing. **U.K.**

**95-1703**

**Design and evaluation of the QUASIMEME inter-laboratory performance studies: a test case for robust statistics.**

W. P. COFINO (Free University, Amsterdam, Netherlands), and D. F. WELLS

*Marine Pollution Bulletin*, 1994, **29**, No 4/5, 149-158

An overview is given of the QUASIMEME inter-laboratory studies designed according to the IUPAC/ISO protocol. The objectives and

organization of the studies, the determinands selected, preparation of materials and the analytical time schedule are outlined. The choice of statistical methods, target performance criteria, assessment of laboratory bias and precision, the submission of data, and data analysis are explained. The Z-score was selected for ranking bias and the P-score as an aid to evaluating precision. Robust statistics were selected since, although these did not discard any observations, they were relatively insensitive to extreme values and tailing distributions. Two algorithms for robust statistics and the conventional ISO 5725 procedure were compared. The heterogeneous nature of the data from the studies seemed suited to this approach. There are 32 references. **Europe**

**95-1704**

**Quality management and practice: evaluation of the QUASIMEME questionnaire.**

S. K. BAILEY (SOAFD Marine Laboratory, Aberdeen), A. S. WELLS, and D. E. WELLS

*Marine Pollution Bulletin*, 1994, **29**, No 4/5, 187-213

The questionnaire seeking information on practices in quality management in marine chemistry laboratories completed by 89 laboratories participating in the QUASIMEME project is considered in detail. The information gathered on laboratory management, quality need, chemical analysis, data handling, reference materials, support services and sample handling is explained. Results are presented and discussed. An overview of the questionnaire is given in an appendix. Sixty-four per cent of laboratories accepted that their quality management measures were inadequate and that quality manuals and standard operating procedures needed development. Structural improvements were required for all areas of information gathering from storage, preparation and analyses to data recording and archiving. A comparison of the data precision in the questionnaire with the actual values found in subsequent inter-laboratory tests indicated that many laboratories did not know their real capabilities. **U.K.**

**95-1705**

**Colorimetric method for the determination of chlorine with 3,3',5,5'-tetramethylbenzidine.**

F. BOSCH SERRAT (Valencia University, Burjassot)

*Talanta*, 1994, **41**, No 12, 2091-2094

The use of 3,3',5,5'-tetramethylbenzidine (TMB) in the colorimetric determination of water of free and combined chlorine was studied. The advantages of TMB as a reagent compared with syringaldazine and o-tolidine for determining chlorine in water were demonstrated. The accuracy obtained was similar to that obtained using the syringaldazine method, and the sensitivity was somewhat higher, but the principal advantages of the proposed method were a greater stability of the reaction product, the absence of interference by high concentrations of calcium and magnesium and the fact that rigorous pH control was not necessary. A detection limit of 2 ng per ml was achieved. **Spain**

**95-1706**

**Gran's plot titration and flow injection titration of sulphate in ground and drinking water with a barium ion-selective electrode.**

O. LUTZE (Institut für Chemo- und Biosensorik (ICB), Münster), B. ROSS, and K. CAMMANN

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 10/11, 630-632

Gran's plot titrations were used in the indirect potentiometric determination of sulphate using a barium ion-selective electrode. The

interference of various ions was established. A flow injection system was developed and used for the continuous determination of sulphate in groundwater and drinking water. Sulphate was determined with a relative standard deviation of 1.5 per cent. Cation exchange was used to separate interfering ions. Linear calibration graphs in the range 50–200 mg of sulphate per litre were obtained by plotting the peak width against the logarithm of the sulphate concentration of the injected samples. The method was successfully applied to samples of groundwater and drinking water. **Germany**

95-1707

The 1993 QUASIMEMF laboratory-performance study: nutrients in sea water and standard solutions.

A. AMINOT (IFREMER, Plouzané, France) and D. S. KIRKWOOD

*Marine Pollution Bulletin* 1994, 29, No 4/5, 159–165

Fifty-five laboratories participated in the 3-part QUASIMEMF nutrients laboratory performance study. Part 1 was a single exercise at 3 concentration levels; part 2 examined long-term repeatability. Both used natural sea water samples. Part 3, also a long-term repeatability exercise, used nutrient concentrates which were diluted in low nutrient sea water. At medium and high concentrations, the relative standard deviation for oxidized nitrogen, nitrite and phosphate was 10 per cent, while for ammonia it was 30–40 per cent. The Z- and P-score statistics demonstrated that 80–90 per cent of the laboratories met target performance at the high concentration levels and that most errors were systematic. Good performance on low-level samples guaranteed similar performance for more concentrated samples. Strict application of reliable procedures should correct most of the shortcomings revealed by this exercise. **Europe**

95-1708\*

Real-time monitoring of nutrients in waters and wastewaters

B. T. HART (Monash University, Melbourne), I. D. McKELVIE, R. L. BENSON, and Y. SHAN

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. Effective control of eutrophication in Australian inland waters requires a knowledge of the dissolved nitrogen and phosphorus levels in the water, preferably on a real-time basis. The development of automatic sensing equipment as a means of achieving this is discussed, with particular reference to the use of flow injection methods of analyses for the determination of total dissolved phosphorus (TDP). Results obtained from the application of a TDP analyses, which incorporated a microwave-powered digestion process, are reported, together with a modified version capable of measuring dissolved reactive phosphorus (DRP). The DRP sensor had been subjected to field trials at a sewage treatment plant in Melbourne with promising results (no component failures during the 16-week trial period, with servicing needed only once a week). In addition, a method for the continuous monitoring of bioavailable nutrient concentrations based on immobilized enzyme probes was undergoing development. Preliminary trials on natural waters had shown that the amount of phosphorus detected by this means (alkaline phosphatase) was quite small. **Australia**

95-1709

Photoacoustic spectroscopic studies on the solid phase cell with a differential type microphone using a diode laser as radiation source

J. SHIDA (Yamagata University, Yonezawa), H. TAKAHASHI, and K. OIKAWA

*Talanta* 1994, 41, No 11, 1861–1864

Photoacoustic spectroscopy (PAS) had previously been used for the determination of phosphate as Molybdenum Blue species adsorbed on uniform anion-exchange beads. However, accurate measurement of phase proved difficult for samples of low absorptivity due to the acoustic background and structural factors of the photoacoustic cell and microphone. Thus, the design and applications of a solid phase photoacoustic cell with a differential type microphone are described. This cell showed higher sensitivity and reproducibility than the cell without the differential microphone. The detection limit for phosphate ion concentrated from 22.5 ml of sample solution on a membrane filter as molybdophosphate *n*-dodecyltrimethylammonium bromide was 3.0 ng phosphate per ml. Using a diode laser (30 mW, 826 nm) as radiation source, the coefficient of variation for 5 measurements at 20 ng phosphate ion per ml was 3 per cent. The calibration graph for phosphate ion was linear over the range 5–50 ng per ml. **Japan**

95-1710

Spectrophotometric determination of H<sub>2</sub>O<sub>2</sub> in marine waters with leuco crystal violet

L. S. ZHANG (Old Dominion University, Norfolk, Va.) and G. T. F. WONG

*Talanta* 1994, 41, No 12, 2147–2145

The absorbance of crystal violet formed by the oxidation of leuco crystal violet by hydrogen peroxide in the presence of the enzyme horseradish peroxidase at 592 nm at pH 4 was used in the determination of hydrogen peroxide in marine waters. The detection limit of the method was about 0.02 µM and the precision within about 1 per cent at a concentration of 0.03 µM. There was close agreement between the results obtained using this method and those obtained using a popular fluorimetric method. Samples could be stored after colour development for up to 5 d before measuring their absorbances without significantly altering the estimated hydrogen peroxide concentration. **USA**

95-1711

Fullerenes as sorbent materials for metal preconcentration

M. GALLI GO (Cordoba University), Y. PEÑI DE PEÑA, and M. VALCARLOS

*Analytical Chemistry* 1994, 66, No 22, 4074–4078

The analytical potential of C<sub>60</sub> fullerenes for the preconcentration of trace metals is discussed. Their large surface area made them potentially useful sorbents by formation of neutral chelates. A model system employing lead in waters and ammonium pyrrolidinedithiocarbamate (APDC) as ligand was used. The APDC-lead chelate was formed in a continuous flow system, sorbed on a C<sub>60</sub> fullerene minicolumn, and subsequently eluted for transfer to an atomic absorption spectrometer (AAS). Two parallel batch experiments were carried out using C<sub>18</sub> bonded silica and activated carbon as sorbents. The primary assets of C<sub>60</sub> fullerenes were a high sensitivity arising from efficient adsorption and high selectivity derived from the special features of this new material. The costs of C<sub>60</sub> fullerenes were seen as prohibitive. Cadmium(II), nickel(II) and iron(III) posed the most severe interferences with the determination of lead using C<sub>60</sub> minicolumns. **Spain**



95-1712

**The 1993 QUASIMEME laboratory-performance study: trace metals in sediments and standard solutions.**

B. PEDERSEN (National Environmental Research Institute, Roskilde, Denmark) and W. P. COFFIN

*Marine Pollution Bulletin* 1994, 29, No 4/5, 166-173

The ability of 55 laboratories to analyse cadmium, copper, lead, mercury, zinc, aluminium and TOC was evaluated in a QUASIMEME inter-laboratory exercise. Three types of sample were provided: a standard solution, a dried sandy sediment from the Doggerbank, and a dried silty sediment from the Elbe. Expert laboratories provided assigned values for elements in the sediments. The differences arising from partial and total determination of the metals were examined; the former arose from aqua regia digestion, the latter by non-destructive techniques or hydrofluoric acid digestion. Results were assessed for bias using the IUPAC/ISO protocol based on Z-scores. Precision was examined by P-scores. In general, laboratory performance was acceptable with only 7 needing to improve quality. Long-term precision was adversely affected by high blank values. Good performance at low concentrations did not guarantee it at high levels. **Europe**

95-1713

**Polarographic determination of nickel and chromium in sewage sludges**

M. KOEB (Fachhochschule Aalen), J. MANN, J. SCHAEFER, F. MÜLLER, G. BOGENSCHULTZ and C. DENGELER

*Acta Hydrochimica et Hydrobiologica* 1994, 22, No 6, 261-264 (in German, English summary)

Polarographic methods were used to determine the nickel and chromium contents of sludges of high and low metal content. Standard aqua regia digestion procedures were employed, the extract being treated with hydrogen peroxide/UV irradiation to further diminish the organic matter content. Both AAS and ICPOES spectrometric determinations were performed for reference; in addition to the polarographic technique using a dropping mercury electrode. Satisfactory agreement between the results obtained by polarography and the spectrometric methods was obtained for nickel in all cases, but for chromium the agreement was satisfactory only following the hydrogen peroxide/UV irradiation of the extract to eliminate interference due to the matrix. (English translation 120 pounds sterling valid for 1995). **Germany**

95-1714

**Effect of potassium iodide on reducing the adsorptive interference of surfactants and organics in the determination of lead and cadmium in environmental samples by differential-pulse anodic stripping voltammetry**

Y. FENG (Open University, Milton Keynes) and R. S. BARRATT

*Analyst* 1994, 119, No 12, 2805-2808

The direct determination of heavy metals in environmental samples by differential pulse anodic stripping voltammetry (DPASV) is often complicated by the presence of organic compounds, particularly surfactants. In this work, the behaviour of lead and cadmium with organics in the presence of potassium iodide was investigated. Up to 100 ppm of pectic acid, agar and gelatin did not affect the voltammetric response of either lead or cadmium. Up to 100 ppm of dodecylamine (DDCA), alginate acid, 40 ppm of camphor and 6 ppm of humic acid did not affect the voltammetric response of cadmium (8 ppb). Up to 100 ppm of camphor, 50 ppm of alginate acid, 20 ppm of humic acid and 10 ppm of Triton X-100 and DDCA did not affect

the voltammetric response of lead (20 ppb). The effect of sodium dodecyl sulphate (SDS) on cadmium was completely eliminated by DDCA, but that on lead was only partly eliminated. Thus potassium iodide not only reduced the effect of adsorption caused by some organics, but also increased the sensitivity of the determination of lead (50 per cent) and cadmium (100 per cent). Lead and cadmium were determined in different fractions of dust samples and synthetic wastewater. The use of silica to adsorb organics was critical in terms of the amount used but, in contrast, the amount of potassium iodide used was not critical. Some organics exhibited a voltammetric response which could be used to determine these organics after masking the responses of metals with EDTA. **U.K.**

95-1715

**Simultaneous determination of lead and cadmium in various environmental and biological samples by differential pulse polarography after adsorption of their morpholine-4-carbodithioates onto microcrystalline naphthalene or morpholine-4-dithiocarbamate-CTMAB-naphthalene adsorbent.**

R. K. DUBEY (Indian Institute of Technology, New Delhi) and B. K. PURI

*Talanta* 1995, 42, No 1, 65-72

A simple, rapid and sensitive method was developed for the direct differential pulse anodic stripping voltammetric (DPASV) determination of lead and cadmium simultaneously following the adsorption of their morpholine-4-carbodithioate derivatives on microcrystalline naphthalene. The preconcentration of these metal ions was also possible by passing their aqueous solutions over morpholine-4-dithiocarbamate-cetyltrimethyl ammonium bromide (CTMAB)-naphthalene adsorbent taken in a column. The microcrystalline naphthalene method was more rapid but the column method gave a better preconcentration factor (8-10 fold). The adsorption on microcrystalline naphthalene was optimal in the pH ranges 5-10 (lead) and 3-4 (cadmium). Metal complexes were desorbed with 10 ml of hydrochloric acid (1M) prior to DPASV analysis. The detection limits were 0.14 ppm for lead and 0.014 ppm for cadmium at minimum instrumental settings. Linearity was maintained in the concentration ranges of 0.7-15 ppm (lead) and 0.07-10 ppm (cadmium) with relative standard deviations of 0.95 and 0.81 per cent, respectively. The method was applied to the analysis of alloys, biological and environmental samples. Tolerance levels for various diverse ions were reported and optimal conditions outlined. **India**

95-1716

**Fluorometric determination of Al in seawater by flow injection analysis with in-line preconcentration**

J. A. REISING (Hawaii University, Honolulu) and C. I. MEASURES

*Analytical Chemistry* 1994, 66, No 22, 4105-4111

This method for the shipboard determination of aluminium in seawater by flow injection analysis (FIA) employed on-line preconcentration of aluminium onto a column of resin immobilized 8-hydroxyquinoline (8-HQ). The aluminium was subsequently eluted from the resin into the FIA system using acidified seawater. Eluted aluminium reacted with lumogallion to form a chelate which was detected by its fluorescence. Excitation and emission wavelengths were set to 484 nm and 552 nm, respectively. The fluorescence was enhanced approximately 5 fold by the addition of a micelle-forming surfactant, Brij-35. The detection limit was 0.15 nM with a precision of 1.7 per cent at 2.4 nM. The method had a cycle time of 3 minutes and could be readily automated. **U.S.A.**

95-1717

**Validation of an operational procedure for aluminium speciation in soil solutions and surface waters.**

J. P. BOU DOT (Nancy University), D. MERLET, J. ROUILLET and O. MAITAT

*Science of the Total Environment*, 1994, 158, 237-252

The speciation of aluminium in soil and surface waters was defined by an operational procedure in which some of the best available methods were optimized and combined. Inorganic aluminium was mostly extracted in 5 seconds by 8-hydroxyquinoline solution. The reaction, which required vigorous agitation, was stopped with methyl isobutyl ketone and the extracted aluminium quinolate was estimated by adsorption readings at 390 and 600 nm. There was little interference except from iron for which a correction was necessary. The identities of the extracted species were obtained by comparing the amount of aluminium extracted from known samples with their theoretical speciation calculated from a chemical equilibrium program. Aluminium fluoride species were not extracted and had to be calculated by equilibrium modelling. Polymeric and colloidal aluminium species were derived from the unrecovered aluminium in ion chromatography using a Dionex CS-3 cationic column. Organic aluminium was taken as that not accounted for by the combined procedure. Applied to Vosges spring waters, the method showed that less than 33 per cent of aluminium was present as toxic species. Aluminium silicate complexes formed a high proportion of non-toxic species. There are 79 references. **France**

95-1718

**New methods for trace titanium determination by adsorptive preconcentration voltammetry with pyrocatechol violet**

D. V. VUKOMANOVIC (Queen's University, Kingston, Ont.) and J. C. W. WILCOX

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 6, 352-358

The first new adsorptive preconcentration voltammetric (AdPV) method for trace titanium analysis was based on the interfacial accumulation of the titanium-pyrocatechol violet (PCV) complex into a hanging mercury drop electrode (HMDE) followed by reduction of the adsorbed complex. The limit of detection was 0.55 nmol titanium per litre after a 30 second collection with a stirred solution at pH 4.9. The method was relatively interference free and was applied to the analysis of complex dissolved materials such as soil and sediments. The second method, which was applied to water analysis, involved catalytic enhancement of the reduction signal with boron trion as catalyst. This catalytic method enhanced the sensitivity of AdPV for titanium by more than an order of magnitude, enabling analysis at the pmol per litre level (ppt). The catalytic mechanism and the reduction pathways were not completely understood. **Canada**

95-1719

**An indirect method for the determination of chromium species in water samples by sequential inductively coupled plasma-atomic emission spectrometry**

M. KORN (Universidade do Estado do Bahia), M. G. A. KORN, B. F. REIS and E. de OLIVEIRA

*Talanta*, 1994, 41, No 12, 2043-2047

A system for the generation of ions for spectrometric determination was developed. The system was based on the oxidative capacity of chromium(VI) ions in acidic media, which promoted the corrosion of copper shavings, producing copper(II) ions in solution. Copper(II) ions produced in solution were generated from the liquid solid

equilibrium sample, metallic copper. Chromium(III) ions did not react with metallic copper, allowing the quantification of chromium species in aqueous samples by inductively coupled argon plasma atomic emission spectrometry in an on-line system. Concentrations in the range 1-50 mg per litre were analysed. A throughput of 100 samples per h with a precision of 10 per cent was obtained. **Brazil**

95-1720

**Analytical application of silica gel modified with didodecylammonium-beta-tridecylammonium iodide**

O. A. ZAPOROZHETS (Taras Shevchenko Kiev University), O. Y. NADZHAFOVA, A. I. ZUBENKO and V. V. SUKHAN

*Talanta*, 1994, 41, No 12, 2067-2071

The nature of the sorption of didodecylammonium-beta-tridecylammonium iodide (DDATI) on different types of sorbents and the possibility of analytical applications of a modified silica gel to some heavy metal determinations were investigated. Spectroscopic and computer methods were used to determine the nature of DDATI adsorption on silica gel. The sorption of anionic metal complexes of cobalt, copper, zinc and manganese on silica gel modified with DDATI was examined. The feasibility of recovering cobalt and copper thiocyanate complexes and determining them by atomic absorption determination was demonstrated. The modified sorbent was applied to cobalt determination in water and a nickel sulphate preparation. **Ukraine**

95-1721

**Selective determination of arsenite by flow injection spectrophotometry**

W. FRENZEL (Technische Universität Berlin), F. HILFENHÄUSER and S. LIEBE

*Talanta*, 1994, 41, No 11, 1965-1971

The well known Molybdenum Blue method was adapted to a flow injection analysis (FIA) system for the selective determination of arsenite. Interfering anions such as phosphate, arsenate and silicate were removed initially by ion exchange. Arsenite was oxidized in-line to the pentavalent state with permanganate and determined using the Molybdenum Blue method. A thorough investigation of optimal experimental conditions for both the separation of interferences and the detection of arsenite is presented. Arsenite was determined in the concentration range 5-500 µg per litre with high precision and reliability, with a sample throughput rate of 20 per h. Recoveries from spiked real water samples were excellent and matrix interferences were negligible. There are 39 references. **Germany**

95-1722

**Analytical determination of mercury in medicinal and waste water samples**

D. C. SAMBIAR (Institute of Science, Bombay) and V. M. SHINDI

*Fresenius Journal of Analytical Chemistry*, 1994, 350, No 10/11, 652-653

A method for the determination of mercury in medicinal and industrial wastewater samples using tri(2-ethylhexyl)phosphate (TEHP) as an extractant was developed. The proposed procedure was rapid at both macro and trace levels of mercury. There was no evidence of interference from associated cations and anions and no need for the use of salting out agents. Mercury(II) was successfully separated from bismuth(III), thallium(III) and lead(II) in binary mixtures. The method facilitated the separation and determination of mercury in medicinal and industrial samples. Precision and reproducibility were both good. **India**

## MONITORING AND ANALYSIS

95-1723

**On-line preconcentration of inorganic mercury and methylmercury in sea-water by sorbent-extraction and total mercury determination by cold vapour atomic absorption spectrometry.** M. FERNANDEZ GARCIA (Oviedo University), R. PEREIRO GARCIA, N. BORDEL GARCIA, and A. SANZ-MEDEL. *Talanta*, 1994, **41**, No 11, 1833-1839.

Three mercury chelating reagents, sodium diethyldithiocarbamate (DDC), ammonium pyrrolidin-1-ylthioformate (pyrrolidine dithiocarbamate, APDC) and diphenylthiocarbazone (dithizone, DZ), were tested for the preconcentration of ultratrace amounts of inorganic mercury and methylmercury in silica C18 minicolumns as the solid sorbent. On-line analyte determination by continuous cold-vapour atomic absorption spectrometry (CVAAS) was coupled with the sorbent extraction procedure. The carbamate type reagents (DDC and APDC) were superior to dithizone for the on-line formation and preconcentration of the corresponding mercury chelates from seawater samples. Using DDC, aqueous sample volumes of 100 ml were preconcentrated with 100 per cent efficiency for both inorganic mercury and methylmercury. DDC chelates were quantitatively eluted with 50  $\mu$ l ethanol. Detection limits of 16 ng mercury per litre were achieved for 25 ml sample volumes. The relative standard deviation was plus or minus 3.4 per cent at 0.5  $\mu$ g per litre levels of mercury(II). **Spain**

95-1724

**Spectrophotometric determination of ziram (dithiocarbamate fungicide) by thiocyanate and rhodamine 6G method.**

L. MATHEW (CSIR Regional Research Laboratory, Trivandrum), T. P. RAO, C. S. P. IYER, and A. D. DAMODARAN

*Talanta*, 1995, **42**, No. 1, 41-43

A new method is described for the estimation of ziram based on the determination of zinc by formation of a ternary complex with potassium thiocyanate and rhodamine 6G at pH 4 to form a pink coloured complex that was stabilized by gelatin. The method was free from copper(II), mercury(II), iron(III), manganese(II) and lead(II) interferences and did not require the removal of hydrogen sulphide. The method was also free from interferences of similar dithiocarbamate fungicides containing manganese(II) and iron(III) ions. Beer's law was obeyed over the concentration range 0.05 to 1.0 ppm of ziram. The method was successfully applied to the determination of ziram in water, vegetables and grain samples. **India**

95-1725

**A method for analysis of fluorensides.**

U. FRITSCH (Fraunhofer-Institut für Umweltchemie und Ökotoxikologie, Schmallenberg-Grafschaft), and S. H. HUTTENHAIN

*Chemosphere*, 1994, **29**, No 9/11, 1797-1802

Total fluorinated surfactant concentrations were measured in aqueous solution by adsorption on activated carbon, drying, combustion in oxygen and adsorption of the gases in a buffer solution. The fluoride content of the buffer was measured by ion-selective electrode. Inorganic fluoride did not interfere. Recoveries exceeded 65 per cent. The method was also applicable to sediment samples which were combusted after drying and without additional preparation. **Germany**

95-1726

**New solvent-free : preparation techniques: based on fibre and polymer technologies.**

A. A. BOYD-BOLAND (Waterloo University, Ont.), M. CHAI, Y. Z. LUO, Z. ZHANG, M. J. YANG, J. B. PAWLISZYN, and T. GORECKI.

*Environmental Science & Technology*, 1994, **28**, No.13, 569A-574A.

In the analysis of organic environmental pollutants, the analytes of interest usually must be separated from samples. Two simple, solvent-free sample preparation techniques based on new fibre and polymer technologies are described: solid-phase microextraction (SPME) and membrane extraction with a sorbent interface (MESI). In SPME a fine, fused silica fibre coated with a polymeric stationary phase (poly(dimethylsiloxane) or poly(acrylate)) is used to extract and concentrate analytes directly from a sample. In MESI a carrier gas stream flows through a hollow fibre membrane, a sorbent interface and then the gas chromatograph. SPME can be used to extract volatile organic compounds in gas, water or soil, PAH and PCB in water or soil, and phenols and pesticides in water. MESI was applicable only to the analysis of volatile and semi-volatile nonpolar analytes. Automation of SPME and MESI is discussed. *In-situ* derivatization is considered. **Canada**

95-1727

**Determination of trace amounts of highly hydrophilic compounds in water by direct derivatization and gas chromatography-mass spectrometry.**

C. MINERO (Università di Torino), M. VINCENTI, S. LAGO, and E. PELIZZETTI

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 6, 403-409

A large group of highly hydrophilic substances, including (poly)hydroxy acids, (poly)carboxylic acids, glycols and dihydroxybenzenes, were derivatized using *n*-hexyl chloroformate which proved to be a more effective derivatizing agent than other alkyl or aryl chloroformates. Thus *n*-hexyl chloroformate was used under strictly controlled reaction conditions and with pyridine or 4-dimethylaminopyridine as the catalyst. Derivatization products were identified and quantified by positive ion chemical ionization mass spectrometry. Detection limits were in the low  $\mu$ g per litre range. Calibration curves were linear over 2-3 orders of magnitude. It was crucial to introduce the chloroformate slowly and under sonication conditions. The derivatization procedure took 2-3 minutes from sample collection to injection into the gas chromatograph. There are 31 references. **Italy**

95-1728

**A wet-oxidation method for determination of particulate organic nitrogen on glass fiber and 0.2  $\mu$ m membrane filters.**

P. S. LIBBY (Oregon State University, Corvallis), and P. A. WHEELER

*Marine Chemistry*, 1994, **48**, No. 1, 31-41.

Six 0.2  $\mu$ m membrane filters were evaluated for the determination of particulate organic nitrogen (PON) by a persulphate wet oxidation method. Bicinchoninic acid (BCA) protein assay was also evaluated as an alternative for PON determination. The membranes were evaluated in terms of filter blanks, chemical interference and adsorption characteristics. Only the 0.2  $\mu$ m TF 200 teflon membrane was entirely satisfactory for both the persulphate wet oxidation determination and the BCA method, with low background nitrogen, no chemical interference, low nitrogen adsorption and better trapping

efficiency. The TF 200 membrane gave a 20-90 per cent increase in PON for Oregon coastal waters over those obtained with Whatman GFF glass fibre filters. Submicron PON could comprise a significant fraction of total PON in seawater. U.S.A.

95-1729

**Use of capillary electrophoresis to monitor concentrations of organic acids in snow and rain water.**

S. TURCAT (Universite de Savoie, Le Bourget du lac), P. MASCIET, and T. LISSOLO.

*Science of the Total Environment*, 1994, **158**, 21-29.

Fourteen samples of snow and rain, taken in the French Alps during spring 1992, were analysed for organic acids by capillary electrophoresis. A buffer of pH 6 was used and the acids detected by direct UV at 195 nm. Formic, acetic, propionic, butyric, oxalic and benzoic acids were separated in 5 minutes at  $\mu\text{M}$  concentrations, samples of only 100  $\mu\text{l}$  were required. The method was free of interference except for oxalic acid. Total concentrations for the 5 acids detected, except oxalic, were 5-10  $\mu\text{M}$  in rain water and 0.5-5  $\mu\text{M}$  in snow. The acids were good geochemical tracers of atmospheric contributions: formic of biogenic activity, acetic of industrial and urban activity, and butyric of bacterial activity. France

95-1730

**Volatile organic analysis by direct aqueous injection.**

S. M. PYLE (U.S. EPA, Las Vegas, Nevo.), and D. F. GURKA.

*Talanta*, 1994, **41**, No.11, 1845-1852.

Direct aqueous injection (DAI) analysis with gas chromatographic separation was studied for 24 volatile organic compounds (VOC). Aqueous samples were directly introduced to a gas chromatograph using fused-silica, mega-bore capillary column separation with subsequent full-scan ion trap mass spectrometric (MS) detection. Internal standardization was used to determine the precision of analysing the 24 VOC by DAI. Comparisons of single-ion response curves to triple-ion response curves showed that triple-ion quantitation was more sensitive and precise than single-ion quantitation. Of the 24 VOC determined at the 20 ppb level, 19 and 20 were detected by the single-ion and triple-ion calibration, respectively. Regression correlation coefficients for the 24 response curves by the 2 methods ranged from 0.910 to 0.998. Precision, measured by per cent relative standard deviation, was best for later eluting compounds and for higher concentrations. Analysis of an environmental sample by DAI was accomplished in 12 minutes and indicated the presence of benzene (80 ppb) and chlorobenzene (2 ppm). This technique was seen as a feasible option for screening for VOC and as having the potential for expansion to include higher boiling compounds. U.S.A.

95-1731

**Solid-phase extraction of polar organic pollutants from water.**

M. C. HENNION (Ecole Supérieure de Physique et de Chimie Industrielles de Paris), and V. PICHON.

*Environmental Science & Technology*, 1994, **28**, No.13, 576A-583A.

The solid-phase extraction procedure is described and compared with liquid-liquid extraction. Three sorbents that can be used for the solid-phase extraction of organic compounds present at trace levels in aqueous samples are alkyl bonded silicas (C8, C18), apolar styrene-divinylbenzene copolymers, and graphitized carbons. The 3 sorbents are compared. A knowledge of the LC behaviour of analytes with the sorbents showed that approximate values for the extraction parameters could be obtained from the characteristics of the solute.

This allowed a better sorbent choice for extracting polar compounds. France

95-1732

**Preconcentration of organic compounds from water across dialysis membranes into micellar media.**

T. M. PEKOL (Miami University, Oxford, Ohio), and J. A. COX.

*Environmental Science & Technology*, 1995, **29**, No.1, 1-6.

The transport of naphthalene across a cellulose acetate dialysis membrane of 500 Da cutoff was enhanced 29-fold compared with water by interaction with the surfactant polyoxyethylene(20)octyl ether. Two per cent aqueous ethanol was usually employed as solvent. The transport continued even when the naphthalene concentration had fallen below that in the receiving solution. With polyoxyethylene(23)lauryl ether, the enrichment factor was 3.4 for naphthalene concentrations of 6.5-130  $\mu\text{M}$  for a 60 minute dialysis from 200 ml to a 2 ml receiver. Comparable results were obtained with *p*-dichlorobenzene as the test compound. The factor was 5.3 when hexane was receiver. Non-specific interactions between the membrane and naphthalene perturbed the flux into the receivers. Solid phase extractions of naphthalene in 2 per cent ethanol with cellulose acetate powder showed a distribution coefficient of 1.8. U.S.A.

95-1733

**Simple and rapid screening procedure for pesticides in water using SPE and HPLC/DAD detection.**

P. PARRILLA (Faculty of Sciences, Almeria), J. L. MARTINEZ VIDAL, M. MARTINEZ GALERA, and A. G. FRENCH.

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No.10/11, 633-637.

A procedure for the simultaneous screening of pesticides using a high-performance liquid chromatography method with a photodiode array detector (HPLC/DAD) was developed. An off-line solid-phase extraction system was combined with the HPLC/DAD for the isolation, recovery and quantification of pesticides from water samples at ppb levels. Pesticides were eluted from a Hypersil C18 column using a combination of isocratic and gradient elution, to separate pesticides with very different water solubilities. Full UV spectra from 200 to 400 nm were recorded on-line during analysis for possible comparison with stored spectra. Pesticides were successfully determined in actual water samples. Spain

95-1734

**A contribution to the qualitative GC analysis of some non-chlorinated xenobiotic chemicals in waste waters.**

B. D. SKRBIC (Novi Sad University), and M. B. VOJINOVIC-MILORADOV.

*Water Science & Technology*, 1994, **30**, No.3, 91-93.

The possibility of unifying the GC retention indices of some alkylbenzenes (AB) and bicyclic aromatic and related compounds (BAC), pollutants in wastewaters, on dimethylsilicone OV-101 and SE-30 stationary phases was investigated. A unified retention index is a statistically obtained value and more reliable than other individual experimental retention values. The values of the unified retention index obtained and its temperature increments were considered reliable if the data included in the regression matrix were from 2 authors and 3 temperatures and no more than 33 per cent of all data were excluded. Serbia

95-1735

## Determination of planar PCBs by combining on-line SFE-HPLC and GC-ECD or GC/MS.

H. R. JOHANSEN (National Institute of Public Health, Oslo), G. BIECHER, and I. GREIBROKK

*Analytical Chemistry*, 1994, **66**, No 22, 4068-4073

On-line coupling of supercritical fluid extraction (SFE) and high performance liquid chromatography (HPLC) was used for the quantitative extraction and clean up of mono-ortho- and non-ortho-substituted polychlorinated biphenyls (PCB) prior to their analysis by gas chromatography with electron capture detection (GC/ECD) or gas chromatography with mass spectrometry (GC/MS). Group separation of different PCB congeners was achieved on a (2-(1-pyrenyl)ethyl)dimethylsilylated silica column. On-line coupling of SFE resulted only in a minor reduction in column efficiency. Average recoveries of non-ortho-substituted PCB from crab hepatopancreas were in the range 71-101 per cent, with the highest recovery for congener PCB-169. For human blood serum and milk, recoveries of congeners 77, 126 and 169 ranged from 35-57 per cent (serum) and from 76-87 per cent (milk), with the lowest recovery for PCB-169. For crab hepatopancreas, the recoveries from on-line SFE-HPLC were approximately equal to those obtained by conventional solvent extraction and off-line HPLC. Recoveries of non-ortho-PCB from blood serum were slightly higher using SFE-HPLC. SFE-HPLC and concentration prior to GC/ECD or GC/MS took about 90 minutes, a 10-fold time compared with conventional extraction method. SFE also avoided the use of large amounts of solvent extractants, though simultaneous parallel extractions were not possible with SFE. **Norway**

95-1736

## Comparison of GC-MS with an *in vitro* bioassay for PCDDs and related compounds in environmental samples

B. G. CHITTIM (Wellington Laboratories, Guelph, Ont.), N. J. BUNCE, K. HUI, C. H. M. TASHIRO, and B. R. YEO

*Chemosphere*, 1994, **29**, No 9/11, 1753-1788

Samples of petrochemical wash water containing different levels of polychlorodibenzo-*p*-dioxin (PCDD) were extracted with dichloromethane evaporated to dryness and the residue cleaned up, then fractionated on silica, alumina and carbon columns. Analysis was by gas chromatography-mass spectrometry. Its results in terms of TCDD equivalent concentration were compared with an assay. This was based on the competitive association of the sample and a fixed aliquot of radiolabelled TCDD for a fixed aliquot of Ah receptor obtained from C57BL/6 mouse liver. Even after the full chromatographic clean up procedure, the assay results were 2.2-7.5 times greater than those obtained by chemical analysis. They were much greater on the initial extracts. The assay might be useful in selecting samples for gas chromatography-mass spectrometry analysis. **Canada**

95-1737

## The 1993 QUASIMEME laboratory-performance study: chlorobiphenyls in fish oil and standard solutions.

D. E. WELLS (SOAED Marine Laboratory, Aberdeen, U.K.), and J. de BOER

*Marine Pollution Bulletin*, 1994, **29**, No 4/5, 174-184

Forty-seven laboratories participated in the QUASIMEME inter-laboratory study of the analysis of PCB. Solutions of PCBs 28, 52, 101, 118, 138, 153 and 180 were supplied in iso-octane and cod liver oil stabilized with butyl-hydroxytoluene. Concentrations of congeners in the oil were 7-124 µg per kg. Assigned values were obtained

from 6 laboratories with a method using lipid removal, fractionation and gas chromatography. Laboratories used their usual methods provided these were validated and under statistical control. Robust statistical analysis gave within-laboratory and between-laboratory standard deviations of 5.7-14.4 and 17.6-37 per cent, respectively. More than 60 per cent of errors resulted from inaccurate calibration, poor gas chromatographic separation and non-analytical mistakes. Areas needing attention were control of long-term precision, chromatographic separation, calibration solutions, calibration methods, calculations and data handling. **Europe**

95-1738

## Practical steps to improve the quality control of the chromatography for chlorobiphenyl and organochlorine pesticide analysis.

C. MEGGINSON (SOAED Marine Laboratory, Aberdeen), C. MCKENZIE, and D. E. WELLS

*Marine Pollution Bulletin*, 1994, **29**, No 4/5, 228-234

The quality assurance and quality control systems of a laboratory were critically evaluated for the determination of PCB and organochlorine pesticides. Failure to update control charts regularly and excessively wide action/warning limits were deficiencies known before the study began. The primary objective was to optimize the gas chromatographic operating conditions so that processing and bias of the analytical results were brought within the ranges specified for the QUASIMEME inter-laboratory exercises. Improvements were effected by calibration before each batch, careful control of gas flow, and monitoring of chromatographic peak characteristics. Repeatability greatly improved and new control limits were set to international guidelines. **U.K.**

95-1739

## Polycyclic aromatic hydrocarbons (PAH) - problems and progress in sampling, analysis and interpretation

R. J. LAW (MAFF Fisheries Laboratory, Burnham-on-Crouch), and J. J. BISCOYA

*Marine Pollution Bulletin*, 1994, **29**, No 4/5, 235-241

Aspects of PAH analysis are considered. Analytical methodology by gas or liquid chromatography often supplemented by mass spectrometry is discussed. Water, sediments, fish and shellfish are the matrices evaluated. Problems in the sampling and analysis of these compounds are explored. Inter-laboratory exercises had revealed poor compatibility both between and within methods, indicating that PAH would be good subjects of a QUASIMEME exercise. Before this was undertaken, a stepwise procedure sequentially to improve calibration, clean up techniques and chromatography was desirable. There are 33 references. **U.K.**

95-1740

## Simultaneous determination of carbaryl and azinphos-methyl in water by first-derivative synchronous spectrofluorimetry

J. L. VILCHILZ-QUIERO (Granada University), J. ROHANO, R. AVIDAD-CASTANEDA, A. NAVALON, and L. F. CAPTAN-VALLIVY

*Fresenius Journal of Analytical Chemistry*, 1994, **350**, No 10/11, 626-629

The pesticides carbaryl (CBL) and azinphos-methyl (AZM) were determined simultaneously in water using first-derivative synchronous spectrofluorimetry. The procedure was based on the alkaline hydrolysis of CBL to 1-naphthol and AZM to anthranilic acid. The constant wavelength difference selected to optimize the determination was 103 nm. CBL was measured at 302/405 nm and AZM at

333/436 nm. The calibration graphs were linear between 2.0 and 500.0 ng CBL per ml and between 1.2 and 500.0 ng AZM per ml with detection limits of 0.62 and 0.35 ng per ml, respectively. The proposed procedure was used to determine both analytes in samples of natural waters. There are 30 references. **Spain**

#### 95-1741

##### **Comparison of an enzyme immunoassay and gas chromatography/mass spectrometry for the detection of atrazine in surface waters.**

B. GRUESSNER (Vermont University, Burlington), N. C. SHAMBAUGH and M. C. WATZIN

*Environmental Science & Technology*, 1995, 29, No 1, 251-254

Water samples were analysed for atrazine by a chemical method and by a commercial immunoassay (EIA) which employed magnetic particles with bound antibodies to facilitate separation after incubation. The latter handled 50 samples in 2 h. For 217 samples, the coefficient of correlation between the results of the 2 tests was 0.96. The EIA produced no false negatives and only 5.53 per cent false positives. It tended to overestimate atrazine by 0.1 µg per litre, probably through cross reaction in the EIA by atrazine metabolites and the structurally related triazine herbicide. The method was a cost-effective screening technique. **U.S.A.**

#### 95-1742

##### **Electrochemical determination of carbaryl oxidation in natural water and soil samples**

J. A. PÉREZ LÓPEZ (Autonoma University, Madrid), A. ZAPARDIEL, L. BERMÚDEZ, E. ARAÚZO and I. HERNÁNDEZ

*Electrochimica Acta*, 1994, 39, No 10/11, 1621-1625

The insecticide 1-naphthylmethyl carbamate, commonly known as carbaryl, was determined in natural water and soils after prior oxidation to 1,4-naphthoquinone using an electrochemical method. Carbaryl was subjected to coulometric oxidation at a platinum electrode using 0.024 mol Britton-Robinson buffer per litre at pH 7.0. The oxidation product, 1,4-naphthoquinone, was reduced at a dropping mercury electrode for the indirect determination of carbaryl after separation on C-18 Sep-pak cartridges by differential pulse potentiometry and directly without separation by adsorptive stripping voltammetry. Trace levels were determined in natural water and soil. There are 33 references. **Spain**

#### 95-1743

##### **Sensitive spectrophotometric method for the determination of propoxur using 4-aminoantipyrine**

B. VENKATESWARULU (Sri Venkateswara University, Tirupati) and K. SESHAIYAH

*Talanta*, 1995, 42, No 1, 73-76

A spectrophotometric method is described for the determination of the carbamate insecticide propoxur (isopropoxyphenyl methyl carbamate) in both pesticide formulations and water samples. Propoxur was first hydrolysed under alkaline conditions to produce a phenolic product which was reacted with 4-aminoantipyrine in the presence of an oxidizing agent (potassium ferricyanide) to produce an orange coloured dye. This dye was extracted into chloroform and the absorbance measured at 472 nm. Using this method, recoveries from water samples spiked at 20-60 ppb levels were in the range 97.2 per cent to 98.6 per cent, with RSD values in the range 0.52-0.62. **India**

#### 95-1744

##### **Determination of 3,3',4,4'-tetrachlorobiphenyl in water by isotope dilution gas chromatography/high resolution mass spectrometry.**

S. SCHNEIDER (National Institute for Environmental Studies, Tsukuba), S. HASHIMOTO, T. YAMAMOTO and M. MORITA

*Chemosphere*, 1995, 30, No 1, 81-87

Tetrachlorobiphenyl (TCAB), a potential carcinogen, was extracted from water with hexane, cleaned-up on alumina and determined by gas chromatography/mass spectrometry. A carbon-13 labelled internal standard (TCAB) was synthesized from carbon-13 labelled benzene according to previously published procedures. Recoveries were 80.0-88.3 per cent. The detection limit of TCAB was around 0.05 µg per litre. **Japan**

#### 95-1745

##### **Sequential and rapid determination of Po-210, Bi-210 and Pb-210 in natural waters**

T. TOKIEDA (Hokkaido University, Hakodate), H. NARITA, K. HARADA and S. TSUNOGAI

*Talanta*, 1994, 41, No 12, 2079-2085

Radon daughter nuclides lead-210, bismuth-210 and polonium-210 were determined in natural waters using a rapid sequential separation method. After isolation of the 3 radionuclides from the sample by co-precipitation with ferric iron, polonium isotopes were first deposited on a silver disc from a 0.5 N hydrochloric acid solution. Next, bismuth isotopes were electro-deposited on a platinum net cathode coupled with a platinum coil anode at 1.2 V. Finally, lead isotopes were electro-deposited on a platinum net cathode at 1.8 V from the remaining solution by adding hydroxylamine hydrochloride as an anodic depolarizer. The method was suitable for meteorological precipitation and other environmental water samples. **Japan**

#### 95-1746

##### **Determination of dimethyl sulphoxide in aqueous solution by an enzyme-linked method**

A. D. HATTON (East Anglia University, Norwich), G. MALIN, A. G. McILWAIN and P. S. LEES

*Analytical Chemistry*, 1994, 66, No 22, 4093-4096

Since dimethyl sulphoxide (DMSO) is widely implicated in the marine biogeochemical cycle of dimethyl sulphide (DMS), a novel and highly specific method was developed for its determination at nanomolar (nM) levels in aqueous solutions. DMS was first removed from solution by purging with oxygen-free nitrogen. DMSO was then reduced to DMS using the enzyme DMSO reductase purified from the bacterium *Rhodospirillum rubrum*. Resultant DMS was cryogenically trapped and analysed by gas chromatography. The detection limit was 0.016 nmol DMSO per sample (maximal volume 100 cm<sup>3</sup>). Precision for standards in the concentration range 0.063-1.0 nmol of DMSO was within 2 per cent. The specificity of the enzymatic reduction of DMSO was proven in tests with a range of organic sulphur compounds including dimethyl sulphonioacetate (DMSP, the major biochemical precursor of DMS in algae). This technique was thought to be useful for freshwater and seawater samples. Depth profiles of DMSO, DMS and DMSP for seawater samples collected in the Pacific Ocean are presented. **U.K.**

95-1747

**The determination of hydrogen peroxide in aqueous solutions by square wave voltammetry.**

L. S. ZHANG (Old Dominion University, Norfolk, Va.), and G. T. F. WONG.

*Talanta*, 1994, 41, No.11, 1853-1859.

A wide range of matrices from distilled deionized water to seawater, representing a large range of pH values, were analysed for hydrogen peroxide directly by square wave voltammetry (SWV). In contrast to direct current and differential pulse polarography, SWV was far more rapid (scan time reduced to a fraction of a second), more sensitive, had a greater dynamic range and a lower detection limit. Furthermore, in SWV, an analysis was completed with a single drop of mercury which minimized the use and eventual disposal of toxic mercury. The dynamic range extended from 0.5 to 1000 nM and the precision was plus or minus 6 per cent at 2.5 µM and plus or minus 2 per cent at 215 µM. The low detection limit allowed this method to be applied to the determination of hydrogen peroxide in rain water samples. U.S.A.

95-1748

**Convolution in time-dependent system from artificial tracer tests responses in porous or karst systems; theory and modeling.**

M. DZIKOWSKI (Universite de Savoie, Chambéry)

*Journal of Hydrology*, 1995, 164, No. 1/4, 287-303 (in French, English summary).

The possibility of carrying out convolution operations on the results of artificial tracer studies and applying transformation methods to system responses in relation to hydrodynamic conditions was examined. The applicability of convolution techniques depended on the linearity and stationarity of the tracer-test system. The conditions in which convolutions were possible were investigated. A convolution integral which made it possible to determine the results of any input in time at one of the outlets of a vectorial system when a tracer test was conducted between the injection point and the outlet is proposed. Theoretical results with variable flow rates are considered. (English translation 295 pounds sterling, valid for 1995) France

95-1749

**Convolution in time-dependent system from artificial tracer test responses; application on a karst system (Causse de Gramat, Lot, France).**

M. DZIKOWSKI (Universite de Savoie, Chambéry), F. DELAY,

J. P. SAUTY, N. CRAMPON, and G. de MARSILY

*Journal of Hydrology*, 1995, 164, No. 1/4, 305-324 (in French, English summary).

Time-dependent tracer test analysis was carried out on the results of artificial tracer tests conducted in varying hydrodynamic conditions in the karst system at Ouyse (Causse de Gramat, France). In tracer experiments carried out in differing hydrological periods, the relationships among responses to an instantaneous injection were clearer in a system defined by 2 inputs, as in the present case. The space occupied by the mass of the tracer during its transfer could be considered independent of the discharge in the range of flow rates studied. Convolutions were carried out on chlorides, nitrates and suspended solids. Computed results were compared with experimental data from the system outflow. (English translation 295 pounds sterling, valid for 1995) France

95-1750

**The calibration of and measurements with cylindrical hot-film probes in water flows.**

A. L. SAMWAYS (Bradford University), J. ALI, M. F. N. AL-DEEN, and H. H. BRUUN.

*Measurement Science & Technology*, 1994, 5, No.12, 1551-1559.

As part of a wider study of bubbly oil/water flows in vertical pipes, for which laser Doppler anemometry (LDS) is unsuitable, hot-film anemometry was studied. An integrated experimental procedure is described for obtaining accurate measurements with both single normal (SN) and X hot-film probes in water flows. Techniques are described to overcome the common problems of temperature variations and contamination in a recirculating test facility, leading to long-term calibration stability. In addition fast, reliable and accurate computer-based calibration methods for both SN and X probes are described. Comparative measurements were taken between an SN and an X probe in a vertical upward water pipe flow, which demonstrated the validity of the developed methods. U.K.

95-1751

**A correlation between optical properties from satellite data and some indicators of eutrophication in lake Garda (Italy).**

E. ZILIOI (IRRS - CNR, Milano), P. A. BRIVIO, and M. A. GOMARASCA.

*Science of the Total Environment*, 1994, 158, 127-133

The potential of Landsat Thematic Mapper imagery for detecting eutrophic trends was evaluated for Garda lake. Biochemical trends of the lacustrine waters over the last 30 years were discerned by sediment core analysis. The Landsat data were obtained in August 1985 with wavelengths from 0.42 to 12.5 µm and a 30 m<sup>2</sup> ground cell resolution. Image processing gave radiance-derived quantities, by means of transects, from the shoreline to the pelagic environment in 2 separate sub-basins marked by different degrees of eutrophication. Recent and present eutrophication trends and the optical properties of the water correlated. This instantaneous information was consistent with that inferred from the sediment logs. Italy

95-1752

**Measurement of the resistivity of high-purity water at elevated temperatures.**

K. R. MORASH (Thornton Associates Inc., Waltham, Mass.), R. D. THORNTON, C. H. SAUNDERS, A. C. BEVILACQUA, and T. S. LIGHT.

*Ultrapure Water*, 1994, 11, No. 9, 18...26.

The problems of determining levels of impurities in high-purity water at the higher temperatures for rinse water for closely-spaced etched lines on semiconductor circuit boards is considered. The work involved collecting improved or first-time data on the sensitivity of conductivity (or resistivity) to temperature, and to the presence of contaminants in the ppb range, at temperatures from 0-100°C, with special attention to the range 60-100°C. Methods of obtaining sufficiently accurate readings of temperature at these higher levels are discussed, and the roles of thermistors and resistance temperature detectors are outlined. Revised values of resistivity across the temperature range, their percentage difference from previously published values, and the theoretical calculations used to compile characteristics such as conductivity in pure water (with sodium chloride impurities) the resistivity (also with sodium chloride impurities) the density of pure water, and the modal dissociation constant of water, all at 5°C intervals from 0-100°C are shown. These gave more accurate results (to within 0.25 per cent over the whole temperature

range) than those from temperature-compensated commercially-available instruments. U.S.A.

#### 95-1753

**Understanding ORP measurement in water and wastewater.** *Water & Wastewater International* 1994, 9, No 6, 26 and 28-29  
Measuring the ORP (oxidation reduction potential) of water or wastewater might be an important factor in oxidizing and reducing operations such as water disinfection, biocide treatment, odour and colour control, organics destruction and dechlorination. Typically ORP electrodes are gold or platinum, and include a reference electrode combined in a single probe and operate over a 0-1000 mV range. In a low-level chlorine test, ORP measurements might be used to determine when dechlorination is completed using a control set point. This enables consistent on line control to be established thus ensuring full oxidation or reduction without reagent wastage. U.K.

## WATER TREATMENT

See also Abstracts 95-1652, 95-1653, 95-1753, 95-1772, 95-1882, 95-1964

#### 95-1754

**Some options for water treatment in disaster situations.** A. P. COTTON (Loughborough University), K. V. ELLIS and M. A. KHOWAJA

*Aqua* 1994, 43, No 6, 303-310

Natural and man-made disasters, such as earthquakes, floods, civil unrest, war and influxes of refugees could damage or overstretch water supply, treatment and distribution systems. A general strategy for planning for the provision of an adequate water supply following a disaster is described. Simple water treatment techniques, which could be important in overcoming a short-term crisis, included storage, boiling, filtration and chemical disinfection. U.K.

#### 95-1755

**Operation and maintenance of small capacity water treatment plants**

J. N. KARDILE

*Journal of Indian Water Works Association* 1994, 26, No 3, 169-174

The inability of small capacity water treatment works in India to provide water of the desired quality was attributed to insufficiently trained operators and high turbidities of raw water during the rainy season. Aspects of works operation and maintenance are briefly presented in the areas of flow and turbidity measurement, sludge dosing, maintenance of pretreatment stages and filters, chlorination records and improvements. India

#### 95-1756

**The use of aeration to improve quality at the De Laak water treatment works.**

A. HAASNOOT (WZHO), L. J. W. HENDRIKS and G. K. REIJNEN

*H<sub>2</sub>O* 1994, 27, No 26, 768-772 (in Dutch, English summary, p. 761)

Problems with a rising number of bacteria and aeromonads in treated water from the De Laak works of the South Holland Water Company treating some 8 million m<sup>3</sup> of groundwater per year began to appear in 1988. Concurrently, levels of methane in the raw water began to

increase. The filters were diagnosed as the source of the bacteria. Removal of the methane by aeration before the filtration stage was assessed experimentally on one of the 8 filters. Bacterial problems declined, and it was found possible to re-use the process air. This gave economic advantages which, together with the finding that the filter could be rated 50 per cent higher, persuaded the company to introduce aeration to all the filters at that works, and to evaluate it at others. (English translation 210 pounds sterling, valid for 1995) Netherlands

#### 95-1757

**Optimization of direct filtration: experiments and mathematical models.**

H. H. NGO (Technology University, Sydney, N.S.W.), S.

VIGNESWARAN and H. B. DHARMAPPA

*Environmental Technology* 1995, 16, No 1, 55-63

The influence of flocs in the direct filtration of kaolin suspensions was studied in a laboratory helical flocculator and rapid sand filter. Two models were used to optimize the process: a flocculation and filtration model and the application of Ives' filterability number. The combination of the first model and experimental results indicated that there was an optimal range of floc size for prolonged filter runs; that alum dose significantly affected floc size and density; a compromise between velocity gradient and flocculation time was essential to optimize performance; and that the optimal filter depth increased at higher filtration rates. Simulations gave floc size, flocculation time and velocity gradient for optimal performance under the selected conditions. When these were compared with the values calculated using Ives' filterability number, all the parameters were higher, especially flocculation time and velocity gradient which were 1.5-3 times larger. The approach helped to find optimal conditions with the minimal number of experiments. Australia

#### 95-1758

**Australian company leads the 'floc' in water clarification.**

*Water & Wastewater International* 1994, 9, No 6, 30

Aquapac International Pty. Ltd. developed a range of products for water clarification to replace the use of aluminium sulphate. One of these was PAC (polyaluminium chloride) which has a faster action and also requires lower doses and creates less sludge. Another product range included FATHLOC for nonpotable effluent treatment, which floats the scum obtained to the surface or sinks it as a sediment. A series of blended flocculents for specific purposes was available, and these consisted of an organic coagulant that depended on the specific application, incorporated with the PAC. Where potable water was to be treated, only approved organics of the prescribed dosage set by law were employed. Australia

#### 95-1759

**Performance evaluation of ceramic filter candles**

M. CHAUDHURI (Indian Institute of Technology, Kanpur), S. K. VERMA and A. GUPTA

*Journal of Environmental Engineering* 1994, 120, No 6, 1646-1651

The ceramic filter candle (Berkefeld filter) and its modification (silver impregnated with or without activated carbon) were popular in the developing world for the home treatment of groundwater. The performance of 2 ceramic filter candles and one silver impregnated ceramic filter candle with a layer of activated carbon, all available in India, was evaluated using *Escherichia coli* and poliovirus challenge tests and a long-term filtration test. None of the candles performed reliably as microbiological water purifiers. It was recommended that



## WATER TREATMENT

specifications/standards should require ceramic filter candles to retain suspended particles down to a size of 1 µm to ensure a bacteriologically safe filtrate. Such candles would not retain human pathogenic viruses. **India**

95-1760

**Fabric of society.**

C. FRANCIS

*Water & Environment International* 1994, 3, No 31-31

Multi-barrier techniques for potable water treatment had been used in emergency systems. They could also be appropriate for permanent systems in developing countries but it was essential to tailor the methods to local needs. Research into the use of fabric filter membranes is reported. **International**

95-1761

**Denitrification by a mixture of bacterial strains derived from an upflow sludge blanket reactor, following entrapment in sol-gel glass.**

R. ARMON (Israel Institute of Technology, Haifa), J.

STAROSVITZKY, and M. GREEN

*Letters in Applied Microbiology* 1995, 20, No 1, 25-28

Whole cell extract of bacteria from a drinking water denitrifying upflow filter were immobilized into sol-glass and the product air dried and powdered. The predominant strains of bacteria were *Pseudomonas*. The product was able to reduce sodium nitrate and nitrite solutions though compared with free whole cell extract the product reactions took twice the time. The denitrifying enzymes within the sol-glass matrix could be used several times without significant loss in specificity but their reactivity gradually reduced. The experiment was the first successful attempt to incorporate denitrifying reductases into sol-glass for experimental denitrification. **Israel**

95-1762

**Drinking water denitrification in a membrane bioreactor**

B. DELL'ANGHI (Ecole des Mines d'Alès), F. NAKAMURA, H.

MYOGA, Y. MAGARA, and L. GILIBAL

*Water Science & Technology* 1994, 30, No 6, 157-160

A membrane bioreactor in which an ultrafiltration membrane was used to retain high concentrations of biomass in the reactor removed nitrate from groundwater in a pilot scale system. Nitrate removals of 99 per cent were consistently achieved. The specific denitrification activities averaged 0.16 kg nitrate nitrogen per kg of mixed liquor suspended solids d at a temperature of 20°C and pH 8. A permeation flux of about 0.5 m<sup>3</sup> per m<sup>2</sup> d was observed irrespective of changes in suspended solids concentration. The specific denitrification activity decreased by a factor of 1.9 with a temperature decrease of 10°C. The process had an ethanol requirement of 1.4 g carbon per g of nitrate nitrogen. **France**

95-1763

**Effects of the modification of activated carbon physico-chemical characteristics on the adsorption of organic compounds.**

F. JULIEN (Faculté des Sciences, Limoges), M. BAUDU, and M. MAZIL

*Aqua* 1994, 43, No 6, 278-286 (in French, English summary)

The role of the surface environment of activated carbon in the adsorption mechanism was studied. Powdered activated carbon (PAC) from 3 different sources were subjected to 2 activation treatments. Boehm titration, zeta potential, specific surface area, water spreading pressure and ionic elements titration were used to

study the influence of thermal treatment on the adsorption. Thermal treatment eliminated surface acid functions which gave rise to an increase in zeta potential of some types of carbon. A Langmuir model was used to investigate the adsorption of organic compounds (sali-cyclic acid, benzoic acid, picric acid and phenol). Thermal treatment allowed an increase in the maximal adsorption capacities of the PAC. (English translation 475 pounds sterling, valid for 1995). **France**

95-1764

**Adsorption of 1,1,2-trichloroethane from river water.**

R. M. NARBAITZ (Ottawa University, Ont.), and A. BENEDEK

*Journal of Environmental Engineering* 1994, 120, No 6, 1400-1415

The competitive adsorption isotherms pertinent to a water-treatment adsorber treating a contaminated water source were studied. The contaminated water was a mixture of 1,1,2-trichloroethane (TCEA) used as a model toxic compound, and the naturally occurring organic matter (NOM) in river water measured as DOC. The adsorbent was bituminous coal based activated carbon. The NOM reduced the adsorption capacity of TCEA, the more weakly adsorbing compound, particularly as the equilibrium liquid phase concentration approached the initial concentration. The TCEA isotherms were affected by the initial concentration of both solutes. The adsorption capacity of background organics was almost unaffected by the presence of TCEA. This was possibly due to adsorption that involved competition in only a fraction of the adsorption sites. The truly predictive models tested could not predict the data obtained in the study. The MSC-AM model, which assumes the existence of noncompetitive adsorption sites, described the data successfully. There are 34 references. **Canada**

95-1765

**Chrome waste as sorbent for the removal of arsenic(V) from aqueous solution.**

K. S. LEO (Agriculture Malaysia University, Selangor), and C.

K. LEE

*Environmental Technology* 1995, 16, No 1, 65-71

The removal of arsenic(V) by chrome sludge was investigated in batch and column laboratory experiments. Arsenic was analysed by hydride generation and inductively coupled plasma atomic absorption spectrophotometry. Sorption followed the Langmuir isotherm model. There was no effect on adsorption in the pH range 2-10, although the sludge tended to dissolve below pH 3. Equilibrium was established within 2 h. Maximal sorption capacity was 21 mg arsenic(V) per g of sludge. **Malaysia**

95-1766

**Efficiency and mechanism of acrylamide removal by permanganate oxidation.**

J. MA (Harbin University of Architecture and Engineering), G.

LI, and N. J. D. GRAHAM

*Aqua* 1994, 43, No 6, 287-295

Potassium permanganate oxidation effectively decreased acrylamide concentration in water. Residual acrylamide concentration decreased as potassium permanganate dosage increased. The higher the initial acrylamide concentration, the faster the degradation rate. There was a very rapid reduction in the initial oxidation period followed by a more gradual reduction. The influence of reducing agents found in natural water on the oxidation was studied. Hydrogen sulphide and iron(II) clearly reduced oxidation efficiency. Humic and fulvic acids slightly reduced efficiency. Nitrite and manganese had little impact. Yellow river water samples were spiked with 100 g acrylamide per

litre. Potassium permanganate dosages of 2.0 mg per litre reduced the acrylamide concentration to below detection limits. Doses above 2.0 mg per litre caused an increase in residual total nitrogen concentration. Potassium permanganate was reduced to manganese dioxide by reducing agents. The manganese dioxide could be largely removed by a coagulation-flocculation-filtration process if an appropriate potassium permanganate dosage was used. Experiments were carried out to investigate the oxidation mechanism. A possible reaction scheme is suggested. **China**

95-1767

**Decomposition of cyanobacterial microcystins by iron(III) chloride**

S. TAKENAKA (Fukuoka Institute of Health and Environmental Sciences) and Y. TANAKA  
*Chemosphere*, 1995, 30, No 1, 1-8  
Microcystins (MC) RR and LR were treated at room temperature with ferric chloride solution under 3 conditions: in 2 cases the weight ratio of ferric chloride to MC was 20 at different pH values, while in the third the ratio was 5 under acidic conditions. Separation of products with a Sep Pak C-18 cartridge was followed by thin layer chromatography. Of 8 chromatographic spots, 3 were ninhydrin reactive. One was identified by gas chromatography/mass spectrometry as 2,6,8-trimethyl-10-phenyldec-4H-6E-dienol-1-ol. The chemical composition product of MC-LR had no acute toxicity to mice. Fifty per cent of both MC-RR and MC-LR were decomposed within 10 minutes at rates unaffected by pH values between 2 and 8. **Japan**

95-1768

**Influence of some groundwater and surface waters constituents on the degradation of 4-chlorophenol by the Fenton reaction**

E. DUCZYNSKA-KOCHANY (Waterloo University, Ontario) and C. STEPHAN (LES HAKMS)  
*Chemosphere*, 1995, 30, No 1, 1-20  
The correlation of 4-chlorophenol (hydroxy-4-chlorobenzene) and ferric ion catalytic concentrations (0.5-3 and 10-60 mM respectively) and on the presence of various anions (at ambient to 3.0 mM) on the rate by high performance liquid chromatography. Anions concentrations ranged from 10 mM to 3 mM mostly the latter. For the same concentration, the reaction rate fell in the order per chlorate > nitrate > nitrite > iodide > chloride. These exerted considerably smaller effect than which broken phosphate and bicarbonate ions, which profoundly depressed the reaction. The degradation followed a similar rate constant for the anion. The influence of phosphate and bicarbonate ions at a moderately low pH were ascribed to their effect on the oxidation of ferrous iron and their scavenging of hydroxyl radicals. There are 32 references. **Canada**

95-1769

**Desalination of well waters by herbal extracts - a case study**

D. L. N. SIMHA, N. REDUNDI, Omprakash V. SHARMA, L. L. K. M. RAO and G. SRIMANNARAYANA  
*Journal of Indian Water Works Association*, 1994, 26, No 3, 18-28  
The addition of extracts of various plants to groundwater is reported briefly and possible beneficial effects of natural products identified. The experiments were carried out for a year. Water became potable after a week period. **India**

95-1770

**Performance of a ceramic ultrafilter in ambient-temperature and hot high-purity water**

W. R. CARRERA (Purity Water Co., San Antonio, Tex.), J. A. WEBB MS and J. ELLISON  
*Chrapure Water*, 1994, 11, No 9, 35-40  
The findings of the first stage of an ongoing assessment of the performance of a ceramic filter for high purity water treatment are presented. It was thought that a filter of this type would have advantages over a polysulphone ultrafilter, in that it would be more tolerant of ozone or hot water used for sanitizing, and more resistant to release of particles under conditions of erratic flow, such as might arise through water hammering in the upstream pipework. The primary test should be for release of metals from those deposited on the ceramic support to form the filter, and any particles and TOC contributed by the filter to the permeate. Tests were conducted on such a filter and on a polysulphone filter, using the same input water at 24°C and 54°C under operation conditions. An external laboratory service was used to quantify the determinands. No significant differences were found between the 2 types of filter at 24°C (the only temperature at which the polysulphone was used), or between the ceramic at the 2 temperatures, and no mechanical damage to the ceramic filter was apparent at the end of the 4 week trial. Future work would examine the effect on the filter of ozone, and of water at 90°C. **USA**

95-1771

**POD treatment growth to continue, but POD polishing loops offer alternative for semiconductor plants**

M. HENLEY  
*Chrapure Water*, 1994, 11, No 9, 14-17  
The comparative value of high purity water polishing carried out at the point of use and carried out up stream at a central site serving several such points, are argued. Against the point of distribution method is the possibility of particle shedding from the pipework. Treatment at the point of use might also generate particles, especially if primary filters are large filters, and there is no subsequent filtration step to remove them. The need to assure acceptable particle size by instrumentation would also be more economically met by instrumentation at a central site than several distributed sites. The performance of systems, or whether might also be influenced by the regularity of water flow. An appraisal of market demand for point of use equipment is appended. **USA**

## UNDERGROUND SERVICES AND WATER USE

See also Abstracts 95-1563, 95-1750

95-1772

**Water from Midmar**

C. PEARSE  
*World Tunneling*, 1994, 7, No 10, 433-444  
The design and construction of the first phase of a long term project by Underground Water to provide water supplies to the expanding population of the region west of Durban, South Africa, are described. This involved the construction of a low lift pump below the wall of the Midmar dam to lift water through a steel pipe line to a new water treatment works at Howick, and then through a gravity tunnel to the Durban area. Construction to date on the portal work and tunnel

## UNDERGROUND SERVICES

outlined. The whole system was scheduled for commissioning in October 1996. South Africa

95-1773

### **Epoxy coating systems for potable water tanks and pipelines.**

N. WHITTLE (Hunting Industrial Coatings)

*Construction Repair* 1994, 8, No 6: 32-34

Development and approval of the Hunting Waterline epoxy lining system for potable water tanks and pipelines is described. Following 3 years of trials, the system was accepted in 1993 by the Drinking Water Inspectorate as meeting all appropriate standards. The material was a fast curing, solvent free, 2 part system applied from a sophisticated computer controlled storage, measuring and spraying facility mounted on a trailer. Applications of the coating system to tanks and water pipelines are described. U.K.

95-1774

### **Outside in.**

B. JOHNSON (Palmer Environmental)

*Water Services* 1994, 98, No 1187: 16 and 18

The benefits of leakage control to a water company are discussed. The principal objectives of a leakage control strategy were to reduce distribution and supply losses and to equate production with demand. Water companies were increasingly looking to independent agencies to provide long term leakage control management and services. The advantages of this outsourcing are considered. Services offered by Palmer Environmental are outlined. U.K.

95-1775

### **Control of hydrogen sulphide by air injection into rising mains.**

K. TAKENAKA (Sewage Works Bureau, Kobe City)

*Journal of Institution of Water and Environmental Management* 1994, 8, No 6: 646-655

Studies carried out into the effect of air injection in the control of hydrogen sulphide in rising pressurized sewage pipelines in Kobe, Japan, are reported. High concentrations of hydrogen sulphide were a serious environmental and maintenance problem in the anaerobic interior of rising mains during the long distance pressure transportation of sewage. The relationship between water quality and the amount of air injected was investigated. The concentration of hydrogen sulphide at the terminal of the rising mains was measured to confirm the effect of the air injection system. Optimal air injection conditions were also determined. Japan

95-1776

### **Estimation of back-up frequencies in practice**

W. BRÜCKNER (Stadt Frechen) and H. G. KOCH

*Korrespondenz Abwasser* 1994, 41, No 11: 2004-2007 (in German, English summary)

The hydraulic performance of a sewerage network is reflected in the frequency with which back up of sewage occurs in the various manholes and inspection chambers, and a method of predicting the frequency is outlined, based on the use of rainfall series data and sewer system models. The HYSTHEXTRAN software package was used in conjunction with a computerized sewer system model to provide the necessary input data for a study of a 110 ha catchment with a total length of approximately 20 km. The critical rainfall events were selected from an extended time series of rainfall data and by combining these with the hydraulic model, the number of back-up occurrences in any given interval of time could be determined. The evaluation and presentation of the results in an easily in-

teligible format is also considered. (English translation 100 pounds sterling, valid for 1995). Germany

95-1777

### **Sewer system measurement programme for north-east Frankfurt.**

H. KRIER (Stadtentwasserungsamt Frankfurt)

*Korrespondenz Abwasser* 1994, 41, No 11: 2008-2022 (in German, English summary)

Discrepancies between the predicted and observed occurrences of sewer system back-up and operation of combined sewer overflows prompted the city of Frankfurt to implement a comprehensive measurement programme for a particular portion of the urban network. The catchment selected had a paved surface area of 610 ha and a total system length of 160 km in the north-east part of the city. At all the exit points from this catchment depth and flow rate recorders were installed, and depth gauges were also installed at all the retention tanks within the perimeter. By utilizing these measurements in conjunction with detailed rainfall data and sewer system characteristics, an updated and realistic databank would be obtained as the basis for a new Urban Drainage Programme. The contract for performing this task was entrusted to a firm of consulting engineers, and the work commenced on 1st March 1994. (English translation 235 pounds sterling, valid for 1995). Germany

95-1778

### **Dimensional design of settled solids-free sewer pipelines with special reference to recent findings concerning sedimentation processes.**

T. SANDER (EWE Aktiengesellschaft, Oldenburg)

*Korrespondenz Abwasser* 1994, 41, No 11: 1960-1962 (in German, English summary)

Recent studies of the sedimentation behaviour of suspended solids in circular pipes are reviewed and their significance for the design of sewers with a view to avoiding the accumulations of settled solids is discussed. The minimal slope requirements necessary to achieve flushing of solids under different flow conditions are considered against a background of different standard procedures and previously recognised methods for sewer design. Where smaller pipelines were concerned, including those up to 1 m diameter, a steeper slope than that advocated by the ATV Code of Practice A110 was advisable. (English translation 110 pounds sterling, valid for 1995). Germany

95-1779

### **Possibilities for financial economy in the design and construction of sewers in areas of low building density**

R. SCHINKE (Ingenieurbüro Schinke & Partner GmbH, Hameln)

*Korrespondenz Abwasser* 1994, 41, No 11: 1974-1987 (in German, English summary)

In areas of relatively low building density the application of the currently accepted design rules and Codes of Practice for sewer systems generally give rise to pipes which are oversized in relation to the amount of sewage they are required to carry. In view of the development of advanced technological measures for internal inspection and flushing of sewer lengths of up to 800 m with the aid of high pressure jetting systems, the need for frequent manholes, large pipes and minimal falls no longer applies, with the result that pipelines can be laid much more economically, and the need for the pipe run to follow a road or public right-of-way can be dispensed with. On the basis of some selected projects, very significant cost savings could be realised, and examples are presented showing that

as much as 60 per cent of the normal cost could be saved by adopting the more cost-effective approaches outlined (English translation 320 pounds sterling, valid for 1995) Germany

**95-1780**

**Design calculations for sewer networks based on the full-flow method.**

V. SIFALDA (Ingenieurburo für Wasserwirtschaft, Dreieich)  
*Korrespondenz Abwasser*, 1994, 41, No 11: 1988-1990 and 1991-1993 (in German, English summary)

A new design approach for sewer systems is described, based on an analysis of the filling process, taking into account the rainfall data (frequency, intensity and duration) appropriate to the area concerned. The solution of the design problem involves a mode of thinking which is intermediate between hydrology and hydrodynamics, and is dependent partly on graphical and partly on numerical techniques. The application of the technique is described with the aid of a worked example. (English translation 195 pounds sterling, valid for 1995) Germany

**95-1781**

**STEINKA - sequential sewerage with a simplified form of sewer construction: a cost-effective solution to foul sewer design in rural areas and on the outskirts of towns.**

L. DAUER  
*Korrespondenz Abwasser*, 1994, 41, No 12: 2196-2201 (in German, English summary)

A novel concept for the design of sewerage networks in less densely populated areas is described which aimed to limit the depth of excavation required to 2.0 m (2.5 m in special cases) and also the diameter of the pipes, by the use of intermediate minipumping stations, small enough to be installed in an inspection chamber, and a simple collector and discharge pump for each property served. The proposed system permitted much reduced capital costs for installation (due to a reduction in the amount of excavation), more rapid installation, and a greater ease and speed of implementation of repairs or alterations to the layout to accommodate subsequent house building. A description of the various system components is presented together with details of 12 sewerage schemes either completed or under construction based on the method described. The annual per person capital costs are estimated as 147.2 DM for a system serving 560 residents and based on a 7 per cent cost of capital. The system had been adopted in a number of areas with a total of around 5000 inhabitants. The problems of formal acceptance by the official drainage authorities are briefly considered. (English translation 290 pounds sterling, valid for 1995) Germany

**95-1782**

**The Kassel supporting plate - trench cross-sections with no lateral clearance.**

N. GIESLER  
*Korrespondenz Abwasser*, 1994, 41, No 11: 1964-1973 (in German, English summary)

Since 1990 a new method of supporting large diameter sewer pipes in an open trench without the need for working space on either side of the pipe had become available. The method was developed and refined in the city of Kassel and the surrounding district. It involved the use of a concrete bedding plate with a concave upper surface matching the curvature of the outside of the pipe. The method of working was to start from the socket end, with each successive length of pipe being slid along the bedding plate to enter the open end of the preceding pipe. The bedding plate was lubricated with a liberal

coating of bentonite suspension on which the pipe floated initially, concrete was poured along both sides of the plate and as the setting process occurred, the water from the bentonite slurry was gradually absorbed, leaving the pipe firmly and rigidly supported. The method had been employed for installation of more than 2000 m of sewer pipes with diameters ranging from 1000 to 2200 mm. The angle subtended by the plate at the centre of the pipe might be either 40 degrees or 90 degrees according to the site conditions. (English translation 275 pounds sterling, valid for 1995) Germany

**95-1783**

**Fit to burst.**

*Water & Environment International*, 1994, 3, No 31, 25  
Groundwater protection was an important issue in Germany with leakage from sewage and effluent pipes a priority. High density polyethylene (HDPE) pipe systems were only as secure as their jointing. A new range of HDPE fittings was developed for wastewater applications. Barcode technology provided fully automatic fusion. Germany

**95-1784**

**From repair to replacement: maintaining underground assets.**

L. NIEMARK  
*Water & Waste Treatment*, 1994, 37, No 12: 36 and 42  
A survey of water company annual spend and major contracts in sewer rehabilitation revealed differences in interpretation between companies as to what was repair and what was replacement. Contractors complained of a lack of water company contracts. Following announcement of the new K factors, companies did anticipate an increase in spending on rehabilitation. U.K.

**95-1785**

**Dimensional calculations for stormwater overflow structures according to the ATV Code of Practice A-128 (1992): studies of the sensitivity of the procedures with special regard to their effects for rural catchments.**

M. ERZMANN (Fachhochschule Rheinland-Pfalz, Trier) and I. WILINSBERG

*Korrespondenz Abwasser*, 1994, 41, No 12: 2202 and 2205-2210 (in German, English summary)

The most recent edition of the ATV Code of Practice for the design of combined sewer overflows has been in use since 1992 as a standard guide to the calculation of storage volumes and tank sizes taking into account a variety of catchment related statistics. The influence of some of these on the capacity of the retention tanks is examined, to highlight their consequences for rural catchments. The factors concerned include population density, annual precipitation, transport time, per person water consumption, fluctuations in dry weather flow and the level of contamination of the combined sewage flow. These aspects are examined with a view to lightening the financial burden on sewerage undertakings, by possibly reducing the size of the retention facilities necessary. (English translation 265 pounds sterling, valid for 1995) Germany

## UNDERGROUND SERVICES

95-1786

### **Management of stormwater pollution by the use of retentive carriageway formations in the urban environment.**

J. D. BALADES (CETE Sud-Ouest), T. G. U'IGHARD, M. LEGRET, and H. MADIEC

*Techniques Sciences Methodes*, 1994, 89, No 11, 631-638 (in French, English summary)

The use of porous surface pavements for large parking areas enabled stormwater runoff to percolate into the underlying formation. Since most of the sewer systems in French cities were combined sewers, especially in the city centres, their capacity to accommodate runoff was strictly limited, and alternative solutions were needed to avoid hydraulic overloading during storm events. A system of carriageway design used for a business park and supermarket parking area is described which incorporates permeable asphalt and concrete layers and a mineral base with a layer of shingle in between acting as a collector. Arrangements were made to take samples of the percolating runoff from different points to assess the degree of pollution abatement occurring during passage through the successive layers. Very considerable reductions in the levels of COD, suspended solids and several heavy metals (aluminium, copper, chromium, lead, iron, nickel and zinc) were observed. These were retained within the porous layers and were mostly situated close to the point of infiltration. The metals were firmly bound to the materials close to the surface of porous asphalt, and even the application of deicing salts to the carriageway did not give rise to any significant release. (English translation 180 pounds sterling, valid for 1995) **France**

95-1787

### **Cleaning up lake Ontario's eastern beaches.**

M. PERENTÉ (Cote & Storie, Mississauga)

*Water & Wastewater International*, 1994, 9, No 6, 20-22

To reduce the faecal coliform levels in Ontario lake water, a 2 stage separation of sewer overflow and stormwater was nearing completion. This system involved the construction of 2 detention tanks to accommodate the sewer overflow and the stormwater. Essentially, the overall tank volume was divided into 2 compartments with the separate flows following different flow paths to the treatment plant. To control any risk, the treated stormwater was discharged 400 m out into Ontario lake where the bacteria would die off before any return to the beach was possible due to the currents. **Canada**

95-1788

### **Cleansing the Emscher**

M. SMITH

*World Tunnelling*, 1994, 7, No 10, 415-416 and 418

Construction of a dual large diameter collector along the bank of the Emscher river in Germany is described. The collector and some of the tributaries were being pipe jacked over long distances by the Belgian company Smet Boring NV in partnership with ground treatment company Keller Grundbau GmbH. The 40 million pounds sterling project also included 8.9 km of large diameter pipelines, 7 jacking shafts and 13 inspection manholes. Details are given of the shaft construction, the earth pressure balancing and the pipejacking operations. **Germany**

95-1789

### **GRP in a different league under the sea.**

*Water Services*, 1994, 98, No 1187, 12-13

The installation of GRP pipes in a rock tunnel as part of South West Water's Penzance and St Ives 'clean sweep' sewerage and sewage treatment scheme is described. The pipes were being laid on concrete

plinths 25 m below the sea bed. The tunnel, lying 2.6 km out to sea off the Cornish coast, would be flooded after completion. The GRP pipe was selected for its corrosion resistance, light weight and good hydraulic flow characteristics. A special system was designed for handling the pipes to transfer them from the horizontal stored position above ground to a vertical position for lowering then down a shaft and back into a horizontal position within the tunnel. **U.K.**

95-1790

### **Runoff, erosion, and polymer application in moving-sprinkler irrigation.**

M. BEN HUR (Agricultural Research Organization, Bet Dagan)

*Soil Science*, 1994, 158, No 4, 283-290

Runoff and erosion problems associated with the use of self-propelled moving sprinkler irrigation systems in Israel are reviewed. Factors giving rise to an increase in runoff and erosion during irrigation, the effect of runoff on crop production, and the effect of polymer application on runoff, erosion and crop yield are considered. High runoff levels with this type of irrigation system were caused principally by seal formation at the soil surface. Preventing runoff movement along the field slope increased crop yields substantially. Application of 20 kg polyacrylamide and 40 kg polysaccharide per ha on the soil surface prior to the irrigation season reduced erosion and runoff levels and increased crop yields significantly. **Israel**

95-1791

### **Recreational use of reservoirs as a factor in the assessment of water resource management schemes.**

M. THIEDI (Landesunweltamt Nordrhein-Westfalen, Essen)

*Wasserwirtschaft*, 1994, 84, No 12, 646-648 and 650 (in German, English summary)

The recreational uses of lakes and reservoirs have assumed a much larger importance in the consideration of the public benefits associated with water management schemes in recent years. The various pursuits such as bathing, boating, windsurfing, fishing and bankside leisure activities had attracted greatly increased numbers of visitors, especially from inland towns and cities, but so far there had been no way of allowing for this in a quantitative manner as part of a multipurpose project assessment. A simple model approach is outlined, based primarily on gravitational theory, in which the numbers of visitors could be calculated from a knowledge of the size of the population in the visitor catchment area, the degree of attraction (including the number of facilities provided), the distance involved and the effect of seasonal and climatic variations. The calculated number of visitors could be combined with estimates of income from admission charges and other tariffs to arrive at a quantitative picture of the social benefits under a range of different assumptions regarding expenditure patterns. The manner in which this could be utilized as part of the overall cost benefit assessment is briefly indicated and some typical estimates for the Beverl reservoir are cited. (English translation 235 pounds sterling, valid for 1995) **Germany**

95-1792

### **Impact of the river Maine drainage scheme on hydro-power generation.**

S. R. COCHRANE (Department of Agriculture for Northern Ireland, Belfast) and N. N. J. HIGGINSON

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 6, 680-686

The Maine river drainage scheme in Northern Ireland was designed to reduce substantial flooding and high water table conditions. The scheme involved river deepening and widening improvements to

tributary streams and field drainage and a new flood control weir. The impact of this scheme on the river flows and on hydro-power generation along the river was examined. Pre- and post-drainage scheme river flows together with pre- and post-drainage scheme potential hydro-electric energy production were determined for the period following completion in 1981. No measurable loss of potential energy production had occurred on the Maine river in the post scheme period. U.K.

## SEWAGE

See also Abstracts 95-1507, 95-1511, 95-1512, 95-1925, 95-1927, 95-1949

95-1793

### What's down.

I. EDWARDS

*Water Bulletin* 1994, No 635, 12-13

A variety of items turn up at sewage works from false teeth, jewellery and golf balls to shopping trolleys and motorbikes. Animals found included a reticulated python. U.K.

95-1794

### Accuracy of flow measurement and control.

I. VALENTIN (Technische Universität München)

*Abwassertechnik* 1994, 45, No 6, 5-6 and 8 (in German)

The importance of reliable flow measurements at the treatment plant intake to insure effective utilization of treatment plant capacity is discussed. The growing realization that compliance with more stringent effluent quality requirements could only be assured if the flow through the plant was maintained constant to within fairly close limits had led to a greater awareness of the need for accurate flow measurement. The current methods of flow gauging in the network are reviewed, the difficulties presented by non-symmetrical cross sections and variable velocity distribution patterns being emphasized. In addition, the need for calibration of the flow meters and the development of reliable control systems is considered against a background of advances in electronic control technology. Some possible future developments are indicated. (English translation 165 pounds sterling, valid for 1995). Germany

95-1795

### Continuous on-line measurements in sewage technology

M. KOHNE (Universität Gesamthochschule Siegen)

*Abwassertechnik* 1994, 45, No 6, 10-15 (in German)

The purposes for which on-line measurements of sewage characteristics may be required in the operation of a sewage treatment plant are discussed. Certain parameters which characterize either the pollution load or the chemical composition of the sewage at any particular point in the treatment sequence are considered, together with the problems associated with their temporal variability. A typical control arrangement for an activated sludge plant equipped for biological nitrogen and phosphorus removal is illustrated, with indications of the points at which on-line measurements are required. In addition to the long-standing availability of methods for the determination of dissolved oxygen, pH and redox potential, all of which can be performed continuously, the need for continuous measurement of ammonia and nitrate concentrations has become more pressing if the necessary nitrogen removal performance is to be consistently achieved. The methods by which such determinations can be per-

formed are considered, and those methods most suited to routine on-line measurements in the sewage plant environment are discussed. (English translation 240 pounds sterling, valid for 1995). Germany

95-1796

### Experience of the use of measurement and control circuits for optimizing plant operation in practice.

I. GRUNFBAUM (Ruhrverband Essen), and F. SCHMITT

*Abwassertechnik* 1994, 45, No 6, 16-23 (in German)

The application of measurement and control systems to the operational control of sewage treatment plants is discussed on the basis of practical experience of the use of numerous instruments and control strategies in the Ruhrverband regional sewage undertaking. The parameters which can be routinely monitored by on-line measuring instruments are described along with some indications of the accuracy and reliability of the available equipment. The particular problems associated with the determination of different forms of nitrogen and phosphorus and the manner in which the results obtained can be utilized to control the performance of the plant are considered. The various control options in the case of a plant carrying out nitrification and denitrification are considered with reference to a comprehensive decision tree based on observations of the concentrations of ammonium nitrogen and nitrate nitrogen in the effluent. Some additional experience with the control of phosphorus removal with the aid of simultaneous coagulation is also presented, based on experiments designed to optimize plant performance at the Iserlohn-Baarbachtal sewage treatment plant, where iron chlorosulphate was dosed into the sludge recycle circuit. Similar optimization trials with respect to nitrogen removal were also carried out at a small treatment plant at Neuenrade (17,500 PE) and a much larger plant at Hallingen (100,000 PE). (English translation 315 pounds sterling, valid for 1995). Germany

95-1797

### The reconstruction of sewage-treatment works in Osaka City

T. YASHITA (Sewage Works Bureau, Osaka)

*Journal of Institution of Water and Environmental Management*

1994, 8, No 6, 615-628

The reconstruction of the 50-year-old Tsumori and Ebisewage treatment works in Osaka City, Japan, is described. This work included flood control, advanced wastewater treatment, improvement of the combined sewerage system, utilization of treated water and sludge, more efficient operation and maintenance, and enhancement of the surrounding environment. System layout and process operation is outlined. The planned reconstruction projects are discussed and work to date is detailed. Future plans are also outlined. Japan

95-1798

### Project control at the Krefeld sewage treatment plant.

H. SCHWARZ (U.T.G. Gesellschaft für Umwelttechnik

Viersen), J. HOFFMANN and S. BUCHHEIT-BUECHER

*Korrespondenz Abwasser* 1994, 41, No 11, 2050-2054 and 2057

2060 (in German, English summary)

The project for the extension and rehabilitation of the Krefeld sewage treatment plant involved an outlay of 273 million DM. To ensure its efficient completion within the allotted time and budget, a project controller was appointed with the entire responsibility of supervising the project on behalf of the client. Further services provided by the project control team during the lifetime of the project involved the site organization, documentation and quality assurance and con-

rol procedures. A description of the working methods and achievements of the project control team during the 2 year duration of the project is presented. In addition to the expert organizational support financial advice in connection with the bookkeeping and capital depreciation methods adopted was also provided when the handover period commenced in October 1991 and was completed by the target date of 31st December 1992, due to a skilfully phased programming of all the necessary tasks. (English translation 360 pounds sterling valid for 1995) **Germany**

95-1799

## Construction and operating costs of existing sewage disposal installations in West Germany: basis of calculation of sewerage charges.

R. PPFCHER (Siedlungswasserwirtschaft, Erkrath)

*Korrespondenz Abwasser* 1994, 41, No 12, 2188-2194 (in German, English summary)

An analysis of the construction and operating costs for sewage treatment plants in the western part of Germany is presented to indicate how the relevant cost factors affected the charges levied on the public for sewerage services. The 4 principal cost components were the operating costs, effluent taxes and the capital costs, the latter being made up of depreciation provisions and the interest on borrowed capital. The results (based on a survey of around 350 municipal undertakings) indicated that running costs contributed only about 26 per cent of the total annual costs, while financial costs accounted for an average of 54.4 per cent of the total. Staff costs (16.4 per cent) and taxes for insufficiently treated discharges (3.3 per cent) accounted for the remainder. The depreciation charges incurred were theoretically based on a value of the replacement costs which was too low. The total costs for various undertakings are also broken down into unit (per person) costs to demonstrate their impact on the individual rate payer, and the variation in charges levied by different undertakings. (English translation 275 pounds sterling valid for 1995) **Germany**

95-1800\*

## Construction aspects for BNR retrofitting to an existing wastewater treatment plant

S. K. MOORE (Cardno and Davies Queensland Pty Ltd)

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.

The design and construction aspects of the upgrading of an existing activated sludge plant for Logan City Council. To enhance the capacity from 120 000 PE to 266 000 at the same time as providing for enhanced nutrient removal are described. The design was based on the UCT process for biological nutrient removal with target values of 2 mg per litre and 5 mg per litre for total phosphorus and total nitrogen in the treated effluent respectively. The contract was let with the provision that the existing treatment plant should remain operational apart from two 6 h shutdown periods for flow diversion. In addition, one of the 4 original oxidation ditches was taken out of service for 4 months to allow conversion to a 13 cell bioreactor. The duration of separate stages of the work is given and completion of the contract within the planned 12 month period was expected.

**Australia**

95-1801\*

## The benefits of conversion of BNR to the MLE process: Penrith sewage treatment plant: a case study.

A. POTTER (Sydney Water Board) and G. LEWIS

*Second Australian Conference on Biological Nutrient Removal*

*from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. Proposals for conversion of an existing BNR plant at Penrith to enable the operation of biological nitrogen removal to be combined with chemical dosing to achieve the desired degree of phosphorus removal are described. Earlier load projections for the plant were far too high and a scaled-down expansion programme is proposed incorporating flow equalization, conversion to the modified Ludzack-Ettinger (MLE) process and multipoint chemical dosing, with deep bed filtration. These proposals were intended to achieve major reductions in ammonia, total phosphorus and pathogen levels in the treated effluent while cost savings of around 50 per cent compared with the original proposals were envisaged. The benefits associated with the revised mode of operation and the magnitude of capital and operating costs incurred are summarized. **Australia**

95-1802

## Facilities for treatment of surface runoff from the Annoeullin development zone, Departement de Nord: summary of operating trials.

J. LEGRAND (DDE du Nord), H. MAILLOT, F. NOUGAREDI and S. DEFFONTAINE

*Techniques Sciences Methodes* 1994, 89, No 11, 639-643 (in French, English summary)

Special stormwater collection, treatment and infiltration facilities were provided to serve a new built up area covering a total of 35 ha, of which 21 ha formed the first stage and a further 14 ha remained to be completed. The roads and paved surfaces were equipped with drains to the treatment plant comprising one enclosed lamellar clarifier, one large capacity sedimentation pond and 2 smaller infiltration ponds. The performance of these items was monitored following a number of rainfall events of varying intensity, during which samples of runoff were collected at intervals from the intake and from the successive treatment stages. The results are discussed with reference to the functional behaviour of the respective items of equipment. The clarifier functioned satisfactorily only when the flow rate was low (much lower than its design capacity) and quickly became overloaded with massive solids carryover unless the accumulated solids were removed at frequent intervals. The sedimentation pond performed satisfactorily irrespective of the hydraulic conditions and produced an effluent which was satisfactory for the infiltration stage. The quality of the runoff entering the plant varied widely depending on the intensity of the rainfall and the duration of the preceding spell of dry weather. Modifications to the lamellar separator would be necessary to improve its performance, including better hydraulic regulation and a greater ease of solids removal. (English translation 110 pounds sterling valid for 1995) **France**

95-1803

## Nosing out the source of smells.

R. A. J. ARTHUR

*Water & Waste Treatment* 1994, 37, No 12, 29 and 54

A comprehensive nuisance control package was being developed from a study of poor air quality at 2 waste handling sites. The public's perception of odour nuisance was linked with actual events in plant operation. The complaints pattern was found to relate to seasonal climatic conditions. Meteorological Office predictions of local climate enabled suction on pipes to be increased when a drop in ambient

air pressure was expected. A recent analytical development was the electronic nose. Similar to sensors used in the drinks industry, environmental sensors were under research which were sensitive to low levels of odour. U.K.

#### 95-1804

##### **Development trends in sewage treatment plant operation and sewage sludge disposal.**

H. WITTE (Universität-GH Siegen).

*Abwassertechnik*, 1994, 45, No.6, 3-4 (in German).

This address which was given as an introduction to the sixth Siegen Symposium on Public Water Services, reviews the changes that have taken place in the treatment of municipal sewage during the last 100 years, leading to the recent imposition of even more strenuous requirements on treated effluent quality for discharges to surface waters, coupled with the problems of sewage sludge disposal. Due to the rapidly rising incidence of sewage sludge associated with more intensive methods of sewage treatment, and an increase in the quantity of waste generated by an expanding population, the cost of disposal has been escalating rapidly to a point where the disposal of sewage sludge can incur a charge of 2000 DM per tonne of sludge solids. These factors provided a sombre background to a discussion of the future development of sewage treatment technology. (English translation 75 pounds sterling, valid for 1995) **Germany**

#### 95-1805

##### **Results and consequences of the treatment of sewage in plants equipped with advanced treatment facilities.**

S. SCHLEGEL (Emschergerossenschaft, Essen)

*Korrespondenz Abwasser*, 1994, 41, No.11, 2030-2041 (in German, English summary).

A wide-ranging review of the changes in sewage treatment plant design and operation which have occurred during recent years in the effort to improve treated effluent quality is presented, based on experience gained from application by the Emscher and Lippe regional sewage undertakings. Each of the stages involved in the treatment of municipal sewage is considered against a background of modern developments, and the effectiveness of the changes in raising the level of treatment performance is assessed. Particular attention is given to the benefits obtained from step-feed nitrification plants and the enhanced phosphorus-removal resulting from a pre-acidification of the primary sludge. Further improvements in certain areas are still desirable, especially with regard to denitrification, and improved design of final settling tanks, especially the spatial arrangement of the inlet and outlet flow passages. (English translation 360 pounds sterling valid for 1995) **Germany**

#### 95-1806\*

##### **An integrated approach to control of effluent nutrient levels.**

D. L. MCGREGOR (Albury City Council, N.S.W.).

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. A comprehensive scheme for the enhancement of treated effluent quality, with recycling of treated effluent for irrigation of cleared woodland and recreational areas adjacent to Albury, N.S.W., is described. The proposals involved upgrading of sewage treatment facilities to provide for biological nutrient removal, coupled with the development of effluent irrigation areas in the floodplain of the Murray river, and the construction of wetland areas for reception of treated water during periods outside the growing season. The performance of the existing treatment plant, to which chemical dosing facilities were already being added, is reviewed, followed by an

outline of the future nutrient management strategy and opportunities for reuse of the reclaimed effluent. **Australia**

#### 95-1807

##### **Bioelimination of fatty wastes following saponification.**

M. KALLEL (Société FRANCEAUX, Sartrouville), G.

MALESIEUX, M. GOUSAILLES, and B. VEDRY.

*Techniques, Sciences, Methodes*, 1994, 89, No.11, 619-623 (in French, English summary).

The problems associated with the accumulation of fatty residues on the walls and liquid surfaces of a sewage treatment plant could be avoided by collection of fats and fatty residues from the source of the discharge and applying chemical treatment with caustic soda to hydrolyse the fat molecules. A typical installation for performing this task is described with indications of the amounts of caustic soda required to raise the pH from an initial level of 4.0 to 9.0, at which the glycerides were broken down with the formation of glycerol and fatty acids. These were readily decomposed further in a normal activated sludge system and the efficiency of treatment was also enhanced, partly due to the absence of a lipid film at the liquid/air interface, and also to the reduced tendency to bulking sludge formation resulting from the presence of readily-degradable organic matter. (English translation 165 pounds sterling, valid for 1995).

**France**

#### 95-1808

##### **Breakthrough in fine screen technology helps avoid environmental problems.**

J. STEVENSON (H2O Waste-Tec)

*Water & Wastewater International*, 1994, 9, No.6, 34 and 37

The Discreen development, which consists of a number of shafts fitted with overlapping and intermeshing discs fitted with an aperture distance appropriate to the screening fineness required (2.5 or 5.0 mm), avoids the high costs and problems associated with current technology. Discreen can be combined with a Muncher unit which is a mechanical disintegrator suitable for solids including rags and plastics, and which has solved pump blockage problems. One of the major applications for Discreen would be the protection of storm overflow channels and in this context, installation is very simple. Other advantages include low noise levels and the capability for being installed below ground, and eliminating environmental problems including odours. **U.K.**

#### 95-1809

##### **Filtering in the flood zone.**

R. MARTIN (Greeley and Hansen Engineers, Chicago, Ill.), T.

WILSON, and R. BIZZARRI.

*Water Environment & Technology*, 1994, 6, No.12, 50-53.

The design, construction and operation of a filtration system for widely-varying flows and suspended solids loading associated with storm water overflows are described. The city of Richmond, Va., was in 1985 required by Virginia Water quality Control Board to ensure that the total suspended solids in effluents discharged to the James river did not exceed, on a 7-d average, 10 mg per litre between June-October, and 18 mg per litre between November-May. Pilot studies for the proposed filters were conducted, using flow rates of 45, 70 and 90 mgd, and with either a single medium (sand, of various grain diameters) or multimedia. Sand, of not less than 3.5 mm diameter, was as efficient as anything else, provided the bed was deep enough, and gave an acceptable run-length. Special precautions had to be taken in the construction of the beds, as their datum line was very close to that of the river, which had a history of flooding. The



## SEWAGE

filters had been effective, giving an average reduction of suspended solids of 66 per cent, to about 3 mg per litre, the rate of reduction was relatively insensitive to changes of flow between 45-70 mgd. The filters were taken out of action during a flood, the suspended solids in the works effluent then rose to 14 mg per litre, but within 2 d of their re-connection they had dropped to 3 mg per litre. Effluent BOD has also reduced by about 50 per cent to 2.5 mg per litre U.S.A.

### 95-1810\*

**Full-scale operation results from BNR plants characterized by steady operation, low N and P effluent and on-line monitoring and control.**

E. BUNDGAARD (I. Kruger Systems AS, Søborg, Denmark), and G. PETERSEN

*Second Australian Conference on Biological Nutrient Removal from Wastewater, Proceedings BNR2 Conference, Albury, N.S.W.* The application of nutrient elimination methods in the course of sewage treatment plant operation is discussed against a background of Danish experience of nutrient pollution abatement for discharges to marine waters, and further application of the technology elsewhere. The principles and biochemical reactions involved in the phosphorus removal treatments are outlined, giving rise to a description of the AAO and Bioridpho processes together with the simplified Bioridpho version. Some typical performance data for Bioridpho and similar plants in Denmark and the U.S.A. are presented, 3 of which consistently produced residual total phosphorus concentrations between 0.5 and 1.0 mg per litre. The importance of sludge fermentation as a means of producing readily degradable carbon compounds for the nutrient removal operations is discussed and various ways of achieving this are considered. Finally the application of on-line process control systems based on the use of continuous sensors for ammonium, nitrate and phosphate is described, and the use of the STAR (Superior Tuning and Reporting) expert system for automated control of the entire treatment process is discussed, with reference to trials at a small Danish treatment plant (26,000 PE) incorporating both chemical coagulation and biological nutrient removal. **International**

### 95-1811\*

**Biological versus chemical nutrient removal: competitive or complementary?**

K. E. BARNETT (ACT Electricity and Water, Canberra, A.C.T.). *Second Australian Conference on Biological Nutrient Removal from Wastewater, Proceedings BNR2 Conference, Albury, N.S.W.* The size of the population of Canberra, A.C.T. (300,000 inhabitants) together with its location at the headwaters of the major inland river system in Australia required that the treated effluent discharged to the Murrumbidgee river, was of an exceptionally high standard. Following an environmental audit of the Lower Molonglo wastewater treatment plant, it was concluded that tighter controls were necessary for nutrient levels in the effluent to protect the ecological health of the receiving water downstream from the plant. This was achieved with the aid of a combination of biological and chemical methods, in which spent pickling liquors from the steelworks in Port Kembla were dosed into the secondary effluent, thus providing a readily-available form of ferrous chloride to act as a coagulant. A modified system of denitrification was also introduced to curtail the nitrogen removal performance to about 50 per cent of the total oxidized nitrogen, as studies indicated that complete removal would favour the growth of the blue-green algae within Burrumbidgee lake. The modified process involved the use of recycled sludge liquors as

a source of carbon in place of methanol dosing at the bottom of the denitrification column. The resulting effluent quality met the criteria laid down for the protection of the aquatic ecosystem below the plant outfall; total phosphorus concentrations averaged 0.07 mg per litre over a 6-month period. **Australia**

### 95-1812\*

**Proceedings of the Second Australian Conference on biological nutrient removal from wastewater, 4-6 October 1994 Albury, N.S.W.**

N. H. PILKINGTON (CSIRO, Clayton, Vic.), and R. C. BAYLY (editors)

*Australian Water and Wastewater Association, Artarmon, N.S.W. 1994. 451pp*

This volume contains 56 papers relating to the application of biological nutrient removal methods to the treatment of sewage effluent with particular reference to their performance under Australian conditions. The various process configurations are distinguished including both continuous and semi-continuous operating modes and experience gained in other countries, especially in Denmark and in North America, in the use of methods for controlling eutrophication of receiving waters is also reviewed. The problems encountered in meeting the quality standards for total nitrogen and phosphorus demanded by Australian water management authorities are discussed, the application of chemical coagulation as a supplementary treatment having become essential in several cases, some of the anomalies connected with the role of *Acinetobacter* organisms in the uptake and release of phosphates in aqueous solution are also explored. The further development of the processes outlined is shown to await the elucidation of those factors essential to stable and efficient operation, particularly for phosphorus removal, on the large scale. **Australia**

### 95-1813

**Optimization of biological phosphate removal at the Sainte-Agathe-des-Monts sewage treatment plant.**

G. BELANGER (Eco-Equipement, Terrebonne, P.Q.), and Y. COMEAU

*Sciences et Techniques de l'Eau 1994. 27, No. 4. 18-29 (in French, English summary)*

The principal characteristics of the Sainte-Agathe-des-Monts sewage treatment plant (rated capacity 10,000-12,000 PE) are outlined including those features which favoured the operation of biological phosphorus removal, namely, a quasi-plug flow regime, a method of liquid mixing without aeration and a tertiary filtration system for elimination of fine suspended solids. However certain other factors were not conducive to successful bioelimination of phosphorus such as the dilute nature of the sewage, the absence of any means of fermentation of primary sludge (no primary settling tank) and the fairly high dissolved oxygen content of the incoming sewage. The performance of the system in its original form is outlined, followed by an account of corrective measures designed to enhance the efficiency of phosphorus removal. These involved modifications to the sewage feed and the aeration regime in the aeration tank, as a result of which a better accumulation of polyphosphates by the biomass was achieved. Other adjustments included an increase in the DO level in the final compartments of the aeration tank, more thorough cleaning of the tertiary sand filters to eliminate carry-over of fine suspended solids, and a revised scheme of operation for the secondary sludge settling tank. These modifications enabled the treated effluent quality to comply with the limiting values with

respect to BOD5 suspended solids and total phosphorus concentrations (English translation 500 pounds sterling valid for 1995)  
Canada

#### 95-1814\*

**Biological nutrient removal: recent retrofit, augmentation and greenfield experiences.**

I. LAW (CMPS&F Environmental Chatswood N.S.W.) and T. WALMSLEY

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference Albury N.S.W.* Brief accounts are given of 3 separate projects involving the introduction of biological nutrient removal treatments at Australian sewage treatment plants. The first concerns the retrofitting of these facilities at the Banora Point plant in the northern district of New South Wales. The plant alterations were designed to allow RAS denitrification with anaerobic, anoxic and aerobic zones being provided in the original extended aeration system. A further project at the Elanora plant was designed to increase total plant capacity from 100 000 to 130 000 PE while providing for biological removal of nitrogen (not more than 10 mg residual nitrogen per litre in the treated effluent) and phosphorus (for quality standards to be implemented later). A third plant formed part of the Rouse Hill development to the north of Sydney where a private consortium was engaged in the construction of facilities for a new community which would eventually house 300 000 people. Stage 1 of this development was under construction with a sewage plant to serve 25 000 PE and included provision for reuse of the treated effluent after chlorination as a domestic non-potable supply. **Australia**

#### 95-1815\*

**Performance of Australian BNR plants**

\* J. HARTLEY (Gutteridge Hoskins & Dives Pty Ltd Brisbane Qld) and I. SICKERDICK

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference Albury N.S.W.* A performance review of 7 Australian biological nutrient removal plants undertaken during 1993 is discussed. The processes were of several different types such as the A/O Phoredox UCT modified UCT and Johannesburg configurations. Daily operating data are summarized indicating the mean effluent phosphorus concentrations and nitrogen removal rates (where applicable) from which it was concluded that all 7 plants were achieving an enhanced level of phosphorus removal but with a substantial degree of variability warranting further investigation. Plant behaviour apparently complied with the UCT model in the majority of cases and effective recycled sludge basin COD concentrations were around twice those measured in the aerobic batch test. At 3 plants nitrate recycle to the anaerobic zone appeared to be reducing biological phosphorus removal and 2 of the plants were compensating for the decline by chemical dosing with alum or pickling bath liquors. Prefermentation of sludge with only short residence times was of limited benefit while optimal phosphorus uptake in the aerobic compartments was assisted by a plug flow hydraulic regime. **Australia**

#### 95-1816\*

**Current practice in BNR in the United States.**

R. D. RFARDON (Camp Dresser & McKee Inc Orlando Fla)

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference Albury N.S.W.* A broad review of the nature and distribution of sewage treatment plants with provision for biological nutrient removal in the U.S.A. is

presented. A survey identified a total of 215 facilities in operation during 1992 comprising about 20 different process types of varying capacity although only 19 had a design flow rate in excess of 75 700 m<sup>3</sup> per d. Design and performance data in respect of the better known process variants are summarized and the actual performance figures in respect of total phosphorus and total nitrogen concentrations are compared with the discharge permit requirement. Although many of the enhanced biological phosphorus removal processes in use were capable of producing mean total phosphorus concentrations of less than 2 mg per litre in the final effluent there were obvious difficulties in achieving this level consistently and in many cases supplementary coagulant dosing was employed to overcome permit violations. The performance data for nitrogen removal covered a wide range which reflected the variety of processes in current use. Plants using the Bardenpho process generally gave very low final effluent total nitrogen concentrations although some notable exceptions were found. The standards achieved probably also reflected the skill of the operators in addition to other external factors. **U.S.A.**

#### 95-1817\*

**Biological nutrient removal - supplementary processes.**

W. K. OGDHAM (British Columbia University Vancouver)

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference Albury N.S.W.* A review of some possible add-on treatments which can be coupled with existing biological sewage treatment plants to confer an adequate capacity for biological nutrient removal is presented. The first 4 of these involve several variants of a primary sludge fermentation treatment designed to hydrolyse sludge solids with the production of short chain volatile fatty acids these then serve as the substrates necessary for biological phosphorus uptake in the subsequent an aerobic stage. The 4 most frequently used configurations involve an aerated primary clarifier, a stationary fermenter/thickener, a completely mixed fermenter with recycle to the primary settling stage or a completely mixed fermenter and additional thickener. Some biochemical data indicating the extent of hydrolysis achieved in typical examples of 3 of these types are presented following which the use of crop irrigation treatments and wetland treatment systems is briefly considered. **Canada**

#### 95-1818\*

**Preliminary design for 30 ML/d nutrient removal works**

I. C. C. SACK (John Wilson and Partners (Queensland) Pty Ltd Brisbane Australia) S. McFALL, B. RABINOWITZ, J. BARNARD and J. ANDERSON

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference Albury N.S.W.* An approach to the design of a proposed 30 million litre per d biological nutrient removal plant capable of meeting effluent quality standards (90 per cent) of either 10 and 2 mg per litre or 5 and 1 mg per litre for nitrogen and phosphorus concentrations respectively is outlined. The approach involved a critique of current knowledge concerning BNR treatment processes, the identification of proven process options for each of the effluent quality standards, selection of the preferred processes in each case and finally preliminary design and cost estimates for the preferred options. The final solution based on a so-called 4 stage Westbank configuration in each case is briefly described. **International**

## 95-1819\*

**Temperature and pH effect on biological phosphorus removal**  
I. H. ESPANTO (Griffith University Nathan Qld)

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference, Albury N.S.W.*  
Published data on the effects of temperature and pH on the efficiency of biological phosphorus removal processes are reviewed and the results summarized. The apparently contradictory results of both bench scale and pilot- and full-scale studies of the temperature dependence of phosphorus removal systems are discussed. Since the processes were originally developed for use in warm climates (South Africa) and lower temperatures favoured an increase in the amounts of dissolved oxygen and electron acceptors thereby reducing the amount of substrate in the anaerobic reactor it was reasonable to adopt a temperature coefficient reflecting the negative effect of lower temperatures while operation at low sludge retention times (less than 5 d) or temperatures (below 12°C) should be avoided. In the case of pH variations there was evidence that outside an optimal range of 6.6-7.4 the effect of pH could be detrimental although higher pH values had not been adequately studied. **Australia**

## 95-1820\*

**The importance of simultaneous nitrification-denitrification in biological nutrient removal activated sludge systems with low F/M bulking control**

K. M. HO (Queensland University St. Lucia) P. F. GREENFIELD and I. I. BLACKALL

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference, Albury N.S.W.*  
A series of laboratory studies was performed to ascertain the optimal conditions for ensuring maximal utilization of degradable organic matter while controlling sludge bulking in biological nutrient removal systems. Several configurations were tested on a bench scale including the intermittent 3 stage Bardenpho process, intermittent and continuous versions of the modified 4 stage Bardenpho (Johannesburg) process and several variable volume sequencing batch systems with different operating strategies. The importance of introducing a period with a high F/M ratio during the initial stages as a means of achieving low effluent nitrate levels was demonstrated with nearly continuous denitrification and nitrification. Conditions were simplified to enable BNR to proceed with a combination of anaerobic and aerobic stages only. This helped to offset the significance of the influent carbon deficiency associated with poor BNR performance and also helped to relieve the intractable sludge bulking problems due to alternating anoxic/aerobic conditions. Several types of filamentous bacteria were identified with *Thiothrix* spp. predominating. **Australia**

## 95-1821\*

**Phosphate removal in a continuous culture system by *Acinetobacter* isolated from activated sludge**

G. VASILIADIS (Monash University Clayton Vic.) J. W. MAY and R. C. BAYLY

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference, Albury N.S.W.*  
Three strains of *Acinetobacter* isolated from pilot plants for biological phosphorus removal and capable of accumulating intracellular polyphosphate under batch culture conditions were investigated under continuous culture conditions in a bench-scale fill-and-draw system. The culture system involved an alternating sequence of anaerobic/aerobic conditions in a medium of controlled carbon/phosphorus ratio, with acetate as the sole carbon source. At a carbon/phos-

phorus ratio of 30:1 one strain (RA3117) was able to maintain an effluent phosphate concentration of less than 1 mg per litre for a period of 24 d. The other isolates when tested under identical conditions were unable to achieve the same degree of phosphorus removal. However, even strain RA3117 failed to show evidence of PHB storage under any culture conditions, suggesting that not all bacteria involved in phosphorus uptake followed the conventional model in which PHB accumulation during the anaerobic stage is an essential adjunct to phosphorus metabolism. **Australia**

## 95-1822\*

**Performance review of the biological nutrient removal process at the West Wodonga purification plant.**

R. van OORSCHOT (Gutteridge Haskins & Davey Pty. Ltd, Melbourne) and J. A. CROCKETT

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference, Albury N.S.W.*  
The results of a performance review of the nutrient removal efficiency of the West Wodonga municipal sewage treatment plant are presented. Since 1991 the plant had been operating according to the UCT process configuration although more recently chemical dosing was installed as a back-up measure. The addition of 100 mg hydrated aluminium sulphate per litre (an aluminium/phosphorus ratio of 4:2:1) reduced from the average treated effluent concentration of total phosphorus from 3 mg per litre (BNR removal only) to approximately 1.1 mg phosphorus per litre. The mean effluent nitrogen concentration (ammonia plus nitrate) was less than 10 mg per litre. Some possible explanations for the less than adequate phosphorus removal results of the biological process are advanced. **Australia**

## 95-1823

**Norse trials**

S. MINETT

*Water & Environment International* 1994, 3, No 31, 28-29

A moving bed biofilm process, launched by Kuldnes, a Norwegian company, overcame the clogging problems of conventional fixed beds. After testing different shapes using short cross sections of extruded plastic piping, the version chosen used cross struts inside the pipe and fins on the outside to protect the biofilm on the external surface. The moving bed biofilm was tolerant of variations in flow, load, pH and toxicity and was capable of quick recovery. The process was compact and could be used for pre-denitrification, post-denitrification or a combination of both. **Norway**

## 95-1824

**Primary fermentation of soluble and particulate organic matter for wastewater treatment.**

R. F. GONCALVES (Universidade Federal do Espírito Santo, Vitória) A. C. CHARLIER and F. SAMMUT

*Water Science & Technology* 1994, 30, No 6, 53-62

An upflow sludge blanket treatment system was developed for the fermentation of both the particulate and the soluble fractions of domestic wastewater. The process used a single reactor to carry out suspended solids retention, fermentation and clarification of the treated effluent. Pilot scale reactors were used to treat various hydraulic loads for a range of hydraulic retention times at a constant temperature. The process achieved low suspended solids residuals and fermentation efficiencies superior to those of existing fermenters. Most of the volatile fatty acids produced originated from the soluble fraction of the wastewater. **Brazil**

95-1825

The effects of external carbon loading on nitrogen removal in sequencing batch reactors.

N F Y TAM (Hong Kong City Polytechnic, Kowloon), G L W LEUNG, and Y S WONG

*Water Science & Technology*, 1994, 30, No 6, 73-81

The effects of easily biodegradable organic carbon substrates on overall nitrogen removal from domestic wastewater in a modified sequencing batch reactor were investigated at bench-scale. Methanol, sodium acetate and sodium propionate were used as the external carbon sources. They were added to the reactors prior to the anoxic stage. Sodium propionate was the most effective carbon source used. With a high dose of propionate or acetate a 95 per cent reduction in wastewater nitrogen was achieved with a 1 h anoxic treatment stage, confirming that the denitrification time requirement could be significantly shortened by supplementary carbon sources, though this benefit had to be balanced against possible increases in effluent BOD Hong Kong

95-1826

Study on nitrified liquor recycling process operations using polyurethane foam sponge cubes as a biomass support medium.

H DEGUCHI (Tokyo Science University, Chiba), and M KASHIWAYA

*Water Science & Technology*, 1994, 30, No 6, 143-149

Ways of using polyurethane foam cubes as a biomass support medium in nitrified liquor recycling processes for nitrogen removal from municipal wastewater were investigated. In one type of process, biomass containing cubes were in contact with both anoxic and oxic stages, while in another cubes were in contact with either anoxic or oxic stages, but not both. Nitrification and denitrification rate coefficients at 20°C in the first type of process were 1.5 and 1.6 times higher respectively than the corresponding coefficients for suspended growth, while in the second type the coefficients were 1.5 and 2.0 times higher, respectively than those for suspended growth Japan

95-1827

Effect of nitrate on phosphorus release in biological phosphorus removal systems.

T KUBA (Delft University of Technology), A WACHTMEISTER, M C M van LOOSDRECHT, and J J HEIJNEN

*Water Science & Technology*, 1994, 30, No 6, 263-269

The effect of the presence of nitrate in the anaerobic phase on the release of phosphorus by biological phosphorus-removing organisms was investigated, with particular attention to the possible role of denitrifying phosphorus-removing bacteria (DPB). DPB were enriched in an anaerobic-oxic or anaerobic-aerobic sequencing batch reactor. The enrichment sludges were used in batch studies of the effect of the simultaneous presence of acetate substrate and nitrate. The metabolism of DPB conformed to the Mino model. Nitrate did not block phosphorus release, but acetate uptake by DPB increased, as DPB utilized acetate for denitrification rather than for phosphorus release Netherlands

95-1828

Wastewater inorganic N and P removal by immobilized *Chlorella vulgaris*.

N F Y TAM (Hong Kong City Polytechnic, Kowloon), P S LAU, and Y S WONG

*Water Science & Technology*, 1994, 30, No 6, 369-374

Cells of the green alga *Chlorella vulgaris* were immobilized in calcium alginate and used in batch culture to remove inorganic nitrogen and phosphorus from primarily-treated effluent. The growth and photosynthetic activity of the immobilized cells and the effects of the cell stocking density on the nutrient removal efficiency of the system were examined. Algal cellular metabolic activities were retained after immobilization. Growth and photosynthetic rates were greater in cells at the lower stocking density. Significant reductions in ammonium-nitrogen and phosphate phosphorus were observed especially in reactors containing algal beads of high density Hong Kong

95-1829

Design calculation and planning aids for integration of existing trickling filters into nitrogen removal.

G MEHLHART (Universität GH Kassel)

*Abwassertechnik*, 1994, 45, No 6, 24-29 (in German)

The problem of upgrading the nitrification and denitrification performance to ensure adequate nitrogen removal in sewage plants based on the use of trickling filters is discussed. The necessity for incorporating an additional denitrification step, and the process configurations necessary in the case of simultaneous, pre- and post-denitrification treatments are reviewed. The possibilities associated with either suspended biomass or fixed film anaerobic reactors are considered, and the results of extensive trials at the Korbach sewage plant using both pre- and post-denitrification treatments are reported. Details of the plant modifications, nitrogen removal performances and sensitivity to extraneous factors are considered. In the case of the post-nitrification trials a 1 m<sup>3</sup> reactor partially filled with foamed polyurethane cubes (Lanpor) was used as a fixed film reactor, and acetol was dosed as a carbon source. Further experiments were performed at Lauterbach treatment plant (25,000-35,000 PE) where a trickling filter was modified by blanking off the bottom air inlets, coupled with recirculation of liquor either from the secondary settling tank or from the second stage activated sludge tank. This produced a very satisfactory level of denitrification, without any noticeable impairment of the nitrification performance. (English translation 240 pounds sterling valid for 1995) Germany

95-1830

Kinetics of biofilms in unsaturated granular media.

Y MUSLU (Istanbul Technical University)

*Journal of Environmental Engineering*, 1995, 121, No 1, 65-83

A dispersed flow hydraulic model using Monod type biological kinetics was developed to investigate the performance characteristics of a granular media trickling filter. Uniform biofilm thickness was assumed. Substrate removal efficiency based on the properties of the medium and feed solution were compared. The model was evaluated with data from 3 series of experiments, each using a different trickling filter. The effect of temperature on the process was examined. Performance at different temperatures could be compared by development of model equations to transform the results obtained to any required temperature. There are 35 references Turkey

95-1831\*

## Nitrification and denitrification in rock trickling filters.

C. K. HERTLE (Gutteridge Haskins & Davey Pty Ltd, Brisbane, Qld.), and K. J. HARTLEY

*Second Australian Conference on Biological Nutrient Removal from Wastewater, Proceedings BNR2 Conference, Albury, N.S.W.* The nitrogen removal performance of conventional trickling filters was investigated as part of a design study for new installations and upgrading of existing plants for biological nutrient removal. Special sampling arrangements enabled a nitrogen mass balance to be performed across the filters and the nitrification efficiency shown to range from 58-72 per cent depending on the time of the year, a substantially lower performance than that predicted for similar loading rates (0.07-0.14 kg BOD per m<sup>3</sup> d). The inferior performance was attributed to the residual BOD, of around 20 mg per litre imposing a limitation on the oxygen supply, the maximal nitrification rate occurring only when the BOD had fallen below 10 mg per litre. Some suggestions for augmenting the nutrient removal performance (including denitrification) of trickling filters are presented as a basis for further investigation. However the most cost-effective method of enhancing nutrient removal was the addition of an SBR type activated sludge system in series. **Australia**

95-1832

## Upgrading of existing trickling filter plants for denitrification.

G. F. MEHLHART (Universitat Gh Kassel)

*Water Science & Technology*, 1994, 30, No 6, 173-179

Possible ways of upgrading trickling filter installations to meet new EU guidelines on nutrient levels in effluents are considered. Experiments were conducted at half- and full scale with activated sludge and fixed-bed reactors positioned before and after existing filter units. Published results from upgraded systems are also considered. Before installing pre- or post-denitrification systems, the existing nitrogen removal rate in trickling filter systems should be examined. In many cases, it was possible to achieve simultaneous denitrification rates in trickling filters as high as 80 per cent, particularly with plastic media filters using settled sludge for recirculation. **Germany**

95-1833

## Denitrification in trickling filters.

B. DORIAS (Universitat Stuttgart), and P. BAUMANN

*Water Science & Technology*, 1994, 30, No 6, 181-184

The feasibility of using trickling filter installations for selective denitrification was investigated, with particular attention to innovative technology involving minimal capital expenditure. The use of covered units to minimize oxygen transfer into the filter while feeding nitrate to the system was examined at several existing installations. The denitrification efficiency of this type of system was comparable with that of upstream nitrogen removal in the activated sludge process. It was possible to combine selective denitrification in such installations with the established advantages of the trickling filter process. **Germany**

95-1834

## Low-footprint solution.

R. DENTON (Bewater Europe), K. BLACK, and S. ALANI

*Water & Waste Treatment*, 1994, 37, No 12, 17-18

To meet bathing water quality standards, many sewage works would be needed at tourist resorts and coastal towns, sensitive areas where land was often limited. Traditional sewage works and activated sludge systems were relatively large installations. Recent developments concentrated on process intensification. An important exam-

ple was the biological aerated filter (BAF). The Bifilm process was a new process which offered advantages over other high-rate systems. Simple to operate, it needed no backwashing, was 20 per cent less expensive than the BAF system and required 50 per cent less land. The 3-stage process comprised a primary bioreactor, a polishing stage and a solids removal system. The Bifilm media had a very high voltage, and quiescent zones were created in the void spaces enhancing the retention of suspended active biomass. An occasional air scour would remove the small amounts of accumulated sludge. **U.K.**

95-1835

## Estimating toxicity of organic chemicals to activated-sludge microorganisms.

B. SUN (New Mexico State University, Las Cruces), N.

NIRMALAKHANDAN, E. HALL, X. H. WANG, J. PRAKASH and R. MAYNES

*Journal of Environmental Engineering*, 1994, 120, No 6, 1459-1469

Inhibition of respiration rates (IC<sub>50</sub>) of activated sludge microorganisms and a commercial surrogate culture, Polytox, for a set of 50 common organic chemicals was determined using the respirometric technique. The correlation between the IC<sub>50</sub> values for the 2 cultures was highly significant. The Polytox culture was more sensitive than the activated sludge culture. Quantitative Structure Activity Relationship (QSAR) models were developed, using a training set of 40 chemicals, to estimate EIC<sub>50</sub> for activated sludge cultures. When the models were tested on 43 other chemicals the predicted IC<sub>50</sub> values agreed satisfactorily with experimentally measured values. **U.S.A.**

95-1836\*

## Full scale optimization of a biological nutrient removal wastewater treatment plant - Bendigo.

G. LOCKWOOD (Coliban Region Water Authority - Bendigo),

W. MURDOCH, and J. JENNINGS

*Second Australian Conference on Biological Nutrient Removal from Wastewater, Proceedings BNR2 Conference, Albury, N.S.W.* Experience acquired during the day-to-day operation of the Bendigo sewage treatment plant based on the modified UCT (University of Cape Town) process in the period from January 1992 to April 1994 is reviewed and the various changes to plant operation introduced during this period (in some cases due to equipment failure) are discussed with reference to their effect on treated effluent quality and phosphorus removal performance. Pronounced decreases in the final total phosphorus concentration were observed in response to overnight shut-down of recycled sludge flow from one of the 4 secondary clarifiers. This reduced the nitrate load in the primary anoxic tank both overnight and also during the period following restarting the pump, when a higher concentration of solids was returned. This highlighted the rate of the clarifier as an integral part of the process of denitrification and enabled total phosphorus concentrations as low as 0.7 mg per litre to be recorded in the final effluent. Nitrogen removal rates were fairly consistent throughout the trial period and further control of return activated sludge flow was expected to give an overall improvement in process stability. **Australia**

95-1837\*

**The development of the microbiology of the Bendigo BNR activated sludge plant during its start-up period.**

G. C. KNIGHT (La Trobe University Bendigo Vic.) R. J. SEVIOUR, E. M. SEVIOUR, J. A. SODELL and R. C. BAYLY

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.*

Populations of polyphosphate-accumulating bacteria observed during the first 10 months of full-scale operation of the Bendigo plant for enhanced biological nutrient removal were subjected to microbiological analysis using classical techniques. The presence of *Acinetobacter*-like clusters was first noticed in the biomass from aerobic, anaerobic and anoxic zones 3 weeks after start-up. However it took 3 months for these clusters to become predominant in the biomass, apparently coinciding with a period of higher phosphorus removal and their morphology became more diverse. Surprisingly when the plant performance declined at the end of 6 months these clusters persisted, although they appeared lower and larger and the individual cells smaller. Of the 234 strains of *Acinetobacter* recorded using streak dilution methods, 68 per cent belonged to the principal genospecies 7 (*Acinetobacter johnsonii*) but a significant number (14 per cent) could not be identified by reference to the Biolog data system. A large number of other Gram-negative polyphosphate-accumulating bacteria were also isolated during the study, of which the most common were members of the genus *Aeromonas*. Similarly several Gram-positive bacteria capable of accumulating polyphosphate were observed during the first 6 months of plant operation after which they apparently disappeared. Further studies of these organisms which were difficult to identify would be desirable. **Australia**

95-1838\*

**Process modelling of volatile fatty acid enhanced biological nutrient removal systems for design and operational troubleshooting.**

R. N. DAWSON (Stanley Environmental Sciences Inc. Vancouver B.C.) W. K. OLDFHAM and K. N. ABRAHAM

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.*

Experience gained from the application of the BIOSIM computer model (modified to allow for phosphorus uptake and release according to Wentzel et al) to the operation of the Kalispell sewage treatment and biological nutrient system is discussed. The parameters required for model simulation studies and the significance of certain overriding kinetic constants in achieving realistic predictions are considered and some descriptions of the calibration and validation procedures involved in the tailoring of the model to the system under test are presented. **U.S.A.**

95-1839\*

**Review of denitrification kinetics in nutrient removal activated sludge plants**

P. GRIFFITHS (Simclair Knight Merz, Spring Hill, Qld.)

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.*

Models of the activated sludge process of the type developed by the Capetown University and IAWPRC are examined with reference to their ability to predict plant performance in plants for biological nutrient removal. The original models included several rate constants and empirical coefficients which were necessary for representing denitrification under a range of conditions. Examination of systems

incorporating biological excess phosphorus removal indicated a departure in practice from the denitrification rates predicted by the models. By re-evaluation of the assumptions and especially the behaviour of different substrates and electron acceptors, it was the models could be refined to allow for differences in behaviour among different groups of organisms, giving an improved predictive performance. **Australia**

95-1840\*

**Purposebuilt fermenter for West Wodonga.**

W. G. C. RAPER (CSIRO Watertex, Rosebank, MDC, Vic.) J. CROCKFITT and P. GLOVER

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.*

Following several years' successful operation of an activated primary tank (APT) at the CSIRO Watertex pilot plant site at Lower Plenty, a full scale version was being installed at the West Wodonga sewage treatment plant. This type of tank, which has been developed and patented by the CSIRO, involves a high sludge retention time with continuous elutriation of the products of sludge fermentation as a basis for enhanced phosphorus uptake by the sludge micro-organisms at the secondary treatment stage. The operation of such a tank, which differs from the standard type of pre-fermenter in current use in Australia, is described, the data indicating that a very low residual effluent phosphorus concentration can be achieved at the outlet from the secondary treatment stage without the necessity for chemical addition. **Australia**

95-1841\*

**Comparative nutrient removal performance**

M. PETERS (Environmental Solutions International Ltd, Leederville, Wash., U.S.A.) M. C. GORONSY and J. JENNINGS

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference. Albury, N.S.W.*

The relative merits of the continuous process of biological nutrient removal based on the modified UCT process adopted at Bendigo, N.S.W., and the intermittent process termed the cyclic activated sludge system (CASS) are compared. The performance of the CASS method is illustrated with reference to 2 plants operating in the U.S.A. at Dundee and Catawba, both of which treated low or medium strength sewage without significant industrial inputs. The phosphorus removal performance of the Catawba plant was such that the treated effluent quality criteria applicable at Bendigo could have been complied with, while the actual phosphorus removal at Bendigo was highly variable during the monitoring period. A design comparison based on the CASS system for meeting the licence conditions for the Bendigo site showed a possible 30 per cent reduction in reactor volume, while eliminating the need for secondary clarifiers. The CASS system also enabled effective control of sludge bulking to be achieved, with low and stable values for effluent suspended solids. **International**

95-1842

**Verification of the fate of a volatile organic compound in activated sludge**

H. MELICER (Brown &amp; Caldwell Consultants, Seattle, Wash.) and W. K. BEDFORD

*Water Environment Research, 1994, 66, No 7, 887-893.*

The fate of the volatile organic compound 1,4-dichlorobenzene (DCB) during the activated sludge treatment of municipal waste waters was investigated by measurement of both DCB and its radi

olabelled isotope in a bench scale activated sludge system DCB removal mechanisms shifted between stripping and biodegradation depending on the degree of acclimation afforded to the biomass. Initially, DCB was preferentially stripped to the vapour phase. The portion of DCB stripped decreased with increasing acclimation. In step tests with unacclimated sludge, DCB loss occurred predominantly by stripping with 60-75 per cent of the influent DCB stripped to the vapour phase. Radiolabelled tests with carbon-14 DCB dosed in an acclimated sludge showed that 25-35 per cent of the influent DCB was stripped. The level of DCB sorption to sludge was minimal. Values of DCB biodegradation rate coefficients varied with sludge acclimation. Values were 3.9-8.8 and 0.02-0.07 litres per g h for acclimated and unacclimated sludge, respectively. U.S.A.

## 95-1843

### **Aerobic denitrification studies on activated sludge mixed with *Thiosphaera pantotropha***

M. KSHIRSAGAR (Centre for Environmental Science and Engineering, Bombay), A. B. GUPTA and S. K. GUPTA  
*Environmental Technology* 1995, 16, No 1, 35-43

Activated sludge from a sewage works was acclimatized in laboratory activated sludge units fed with synthetic sewage enriched with nitrate. Cultures of *Thiosphaera pantotropha* were also acclimatized. Denitrification experiments were carried out with nitrate concentrations up to 425 mg nitrogen per litre at a dissolved oxygen level of 2.5 mg per litre with and without the culture. Nitrate was removed to the extent of 16-29 per cent in its absence. In its presence, at hydraulic retention and sludge retention times (SRT) of 0.5-1 and 2-8 d, respectively, removals were 75-85 per cent. There was no clear relationship between nitrate removal and SRT; the latter's effect on *T. pantotropha* numbers could not be evaluated. However, its aerobic denitrification capabilities were demonstrated. Since denitrification generated alkalinity, the need for active pH control as nitrification took place would also be reduced. India

## 95-1844

### **A new process for removal of nitrogen in sewage plants incorporating biological treatment.**

M. BEWERNICK (NTRA Gesellschaft für Biotechnik mbH, Hamburg), B. SEYDLER and R. STUVEN  
*Korrespondenz Abwasser* 1994, 41, No 12, 2261, 2262 and 2265, 2268 (in German, English summary)

A process for the enrichment of nitrifying bacteria was applied to enhance the nitrification performance at 2 sewage treatment plants for which ammonia-rich sludge liquor was employed as a culture medium in a special tank, and the resulting biomass suspension was introduced into the aeration tank of the activated sludge system, thereby greatly increasing the proportion of nitrifiers in the biomass. An actively nitrifying biomass could be maintained, while nitrite was eliminated and denitrification also occurred to an appreciable extent, giving a substantial degree of nitrogen removal. Further tests in a bench-scale system indicated that the addition of aluminium hydroxide as a carrier material not only increased the density of the nitrifiers but also promoted the denitrification reaction even under mildly aerobic conditions so that nitrite and nitrate were both completely eliminated. Once the addition of the hydroxide ceased, the level of nitrate in the effluent increased rapidly. The causes of this apparent denitrification under aerobic conditions are discussed but were not fully understood. (English translation 235 pounds sterling, valid for 1995). Germany

## 95-1845

### **Nitrification as a source of soluble organic substrate in biological treatment.**

B. E. RITTMANN (Northwestern University, Evanston, Ill.), J. M. REGAN and D. A. STAHL

*Water Science & Technology* 1994, 30, No 6, 1-8

The hypothesis that the formation of soluble microbial products by nitrifying bacteria could provide an additional organic substrate for heterotrophic bacteria, increasing their accumulation and stability when inputs of organic substrates were low, was investigated. In chemostat studies, both a nitrite-oxidizing strain (*Nitrobacter* species) and an ammonium-oxidizing strain (*Nitrosomonas europaea*) showed an ability to produce soluble microbial products which could support heterotrophic bacteria. A small heterotrophic population was maintained, apparently through utilization of nitrifier-produced organic matter. A preliminary kinetic analysis of processes taking place was undertaken. U.S.A.

## 95-1846

### **Nitrification inhibition - a method for the estimation of actual maximum autotrophic growth rates in activated sludge systems**

O. NOWAK (Vienna Technical University), P.

SCHWEIGHOFER and K. SVARDAI

*Water Science & Technology* 1994, 30, No 6, 9-19

The extent of nitrification inhibition in pilot- and full-scale activated sludge systems was quantified on the basis of measurements of the actual maximal autotrophic growth rate. This parameter helped to detect low nitrification capacity before an increase in the effluent ammonia level was observed. It was easily determined using respirometry, allowing low nitrification capacity to be noted and acted on in time to prevent effluent ammonia peaks. Two case studies showed that nitrifying activated sludge systems could become acclimatized to inhibitory compounds but had to be protected during acclimatization from peak loads of both nitrogen and inhibitory compounds. Australia

## 95-1847

### **Assessment of nitrification-denitrification potential of Istanbul domestic wastewaters.**

D. ORHON (Istanbul Technical University), S. SOZEN and F. U'BAYO

*Water Science & Technology* 1994, 30, No 6, 21-30

The potential of Istanbul domestic wastewaters for biological nitrogen removal was evaluated experimentally. Parameters characterized included relevant carbonaceous and nitrogenous wastewater components and significant rate coefficients affecting aerobic and anoxic processes. The results showed a low ratio of biodegradable carbon to nitrogen and a relatively small readily-biodegradable (COD) fraction. A new procedure for determining the maximal specific growth rate of autotrophic biomass is proposed, as were correction factors for biological growth and hydrolysis in anoxic conditions. Biomass growth characteristics were highly wastewater-specific. Turkey

95-1848

**High rate and compact single sludge pre-denitrification process for retrofit.**

H. EMORI (Hitachi Plant Engineering and Construction Co. Ltd Tokyo), H. NAKAMURA, T. SUMINO, T. TAKESHIMA, K. MOTEGI, and K. TANAKA

*Water Science & Technology*, 1994, 30, No 6, 31-40

A compact single-sludge pre-denitrification process using immobilized nitrifying bacteria was developed for sewage works with limited space for expansion. Pellets containing the immobilized nitrifiers were dosed into the nitrification tank of a single-sludge pre-denitrification process. This made it possible to perform simultaneous removal of BOD and nitrogen in a retention time similar to that used in the conventional activated sludge process, even at low wastewater temperatures (10°C). The proposed modification was installed in a conventional 3000 m<sup>3</sup>/d activated sludge system and operated successfully. **Japan**

95-1849

**Nitrogen elimination from sludge treatment reject water - comparison of the steam-stripping and denitrification process.**

H. TEICHGRABER (Emschergerossenschaft/Lippeverband Essen) and A. STEIN

*Water Science & Technology*, 1994, 30, No 6, 41-51

Half scale pilot units were used to compare steam stripping and nitrification/denitrification for the elimination of nitrogen from sludge treatment reject water at the central sludge treatment facility of the Emschergerossenschaft in Bottrop. Both systems achieved removal efficiencies greater than 90 per cent. Full scale operation of both processes was feasible. The nitrification/denitrification process was designed for a loading of 0.07 kg nitrogen per kg mixed liquor suspended solids/d and a hydraulic retention time of 1.4 d. Treatment costs were expected to be in the range 5-7.5 DM per kg of nitrogen. **Germany**

95-1850

**Nitrogen removal efficiency and capacity in biofilms with biologically hydrolysed sludge as a carbon source**

A. AFSÖY (Trondheim University) and H. ODI GAARD

*Water Science & Technology*, 1994, 30, No 6, 63-71

The feasibility of using biologically hydrolysed sludge as a carbon source for the denitrification process in biofilms was studied. The hydrolysis process used was designed to achieve a high degree of solubilization of the organic matter in the sludge. On average, 66 per cent of the soluble organic matter consisted of volatile fatty acids. Only these were utilized as carbon source in the denitrifying biofilm. The denitrification rate with respect to the concentration of volatile fatty acids was described using a hyperbolic Monod type function. A simulation example is provided to illustrate the nitrogen removal capacity achieved when the carbon source was provided by sludge hydrolysis. **Norway**

95-1851

**A comparison between ethanol and methanol as carbon sources for denitrification.**

M. CHRISTENSSON (Lund University), E. LILJ and T. WEILANDER

*Water Science & Technology*, 1994, 30, No 6, 83-90

The performance of ethanol and methanol as carbon sources for denitrification was evaluated using 2 chemostats operated in parallel. Pure culture studies were also carried out on one ethanol-utilizing and one methanol-utilizing denitrifier. Ethanol was significantly

more readily available as a carbon source for denitrification than methanol. Denitrification was more easily established and stabilized with ethanol than with methanol and denitrifiers with ethanol as carbon source grew 2-3 times more rapidly than those with methanol as carbon source. The amount of COD required to denitrify a given amount of nitrate was slightly lower for ethanol than for methanol in the continuous experiments. **Sweden**

95-1852

**Influence of dissolved oxygen and oxidation-reduction potential on the denitrification rate of activated sludge.**

E. LILJ (Lund University) and T. WEILANDER

*Water Science & Technology*, 1994, 30, No 6, 91-100

Batch experiments were conducted to determine the influence of low dissolved oxygen concentrations and of the oxidation-reduction potential on denitrification activity in activated sludge. Oxygen had a negative effect on denitrification, even at concentrations below those measurable using conventional oxygen probes (less than 0.1 mg per litre). The oxidation-reduction potential was a useful indicator of low dissolved oxygen concentrations. The denitrification rate decreased linearly with increasing oxidation-reduction potential though the size of this effect varied among sludges from different treatment facilities. **Sweden**

95-1853

**Nitrogen removal in activated sludge systems including denitrification in secondary clarifiers.**

H. SIEGRIST (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf) and W. GUJER

*Water Science & Technology*, 1994, 30, No 6, 101-111

Two treatment facilities with different secondary clarifier systems were compared with respect to the contribution of denitrification in the secondary clarifier to the overall nitrogen removal achieved. A model was developed for the estimation of denitrification capacity and the design of activated sludge systems for nitrogen removal. Data from the 2 facilities were used to develop and verify the model. The model took account of denitrification in the secondary clarifier, wastewater composition (particularly soluble and particulate degradable COD), oxygen input into the anoxic volume, temperature and solids retention time. The effect of aerated grit chambers and primary sedimentation on denitrification was also studied. **Switzerland**

95-1854

**Synthesis of denitrification enzymes in activated sludge: modelling with structured biomass.**

D. WILID (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf), R. von SCHULTHEISS and W. GUJER

*Water Science & Technology*, 1994, 30, No 6, 113-122

A mathematical model for denitrification with structured biomass taking account of the synthesis and decay of denitrification enzymes was developed to improve the description of experimental data. The model was able to predict concentrations of nitrate, nitrite and nitrous oxide. Kinetic parameters were estimated and used to simulate the effect of cell saturation with enzymes in a wastewater treatment process. Low concentrations of dissolved oxygen in the anoxic reactor inhibited enzyme synthesis and activity, so reducing denitrification efficiency. Enzyme synthesis in the sludge blanket of a secondary sedimentation tank could enhance denitrification efficiency. Benefits of modelling with structured biomass are considered. **Switzerland**



95-1855

**Nitric and nitrous oxides from denitrifying activated sludge at low oxygen concentration.**

R. von SCHULTHEISS (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf), D. WILD and W. GUJER

*Water Science & Technology*, 1994, 30, No 6, 121-132

Two batch experiments with different nitrite concentrations were performed to determine the net production of the denitrification intermediates nitric oxide and nitrous oxide in denitrifying activated sludge with a low oxygen concentration. High nitrite and aerobic conditions favoured the production of nitrous oxide but not nitric oxide. The highest emission of nitric oxide took place in completely anoxic conditions. A model describing the reduction of nitrate, nitrite and nitrous oxide and taking account of non-competitive inhibition of these processes by oxygen and nitrite was developed. Nitrite served principally as a denitrification intermediate rather than as an inhibitor. **Switzerland**

95-1856

**Acetylene inhibition for measuring denitrification rates in activated sludge.**

S. HALLIN (Swedish University of Agricultural Sciences, Uppsala) and M. PERL

*Water Science & Technology*, 1994, 30, No 6, 161-167

The acetylene inhibition technique was adapted to studies of denitrification in activated sludge to determine whether systems designed for nitrogen removal were operating at their potential capacity. The technique measured the accumulation of nitrous oxide after inhibition by acetylene. Denitrification rates obtained using this technique were compared with those calculated using mass balances of total nitrogen and those based on nitrate utilization. The comparison confirmed the reliability of the inhibition technique. The potential for obtaining more rapid rates of nitrogen removal is considered in the case of the Kungsängen works. **Uppsala, Sweden**

95-1857

**A test method to determine inhibition of nitrification by industrial wastewater.**

B. BOHM (Munich Technical University, Garching)

*Water Science & Technology*, 1994, 30, No 6, 169-172

A biological testing system to identify the presence of nitrification-inhibiting substances in waste waters was developed. The system was based on a packed bed fixed film biological reactor operated as a differential reactor. The effects on nitrification of wastewaters from the textile and leather industries were investigated. Inhibition was often detected even with considerable dilution of the wastewater. Tannery wastewaters posed severe problems for biological nitrification systems, giving rise to a degree of inhibition similar to that produced by a solution of 2 mg allylthiourea per litre, a compound known for its strong inhibition of nitrification. **Germany**

95-1858

**Nitrogen and phosphorus removal in a 2-stage activated sludge-trickling filter system.**

P. SCHLEYPEN (Bayerisches Landesamt für Wasserwirtschaft, München), W. NORDMANN

*Korrespondenz Abwasser*, 1994, 41, No 12, 2242-2244 and 2247-2249 (in German, English summary)

The existing 2-stage sewage treatment plant serving the town of Roth (65 000 PE) in the Mittelfranken district was upgraded by the provision of an additional denitrification sludge and the introduction of

simultaneous coagulation in the aeration tank. The results obtained from operating trials before and after the installation of the new facilities are reviewed, confirming the effectiveness of the new measures in meeting the more stringent effluent quality standards and nutrient elimination percentages. Denitrification at the inlet to the aeration tank was assisted by the recirculation of a part of the trickling filter effluent; the trickling filter continued to achieve a sufficient degree of nitrification after the modifications were introduced, and the additional costs in terms of power consumption were fairly small. Details of plant operation, effluent composition and nutrient loadings are reported and some general conclusions regarding the upgrading of similar treatment plants are presented. (English translation 250 pounds sterling, valid for 1995). **Germany**

95-1859\*

**Nitrogen and phosphorus removal in the cyclic activated sludge system.**

M. C. GORONSZY (Transenviro Inc., Irvine, Calif., U.S.A.)

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.

The principles of the cyclic activated sludge (CASS) system are outlined, involving a modification of the sequencing batch reactor (SBR) principle comprising 3 successive reaction zones, all of which are in continuous fluid communication. The first zone, termed the biological contactor, operates as a mixing zone for the biomass recycled from Zone 3 and the incoming wastewater; the second zone is an intermediate zone in which most of the nitrogen removal takes place and the third zone, which can be aerated intermittently, performs the functions of a normal activated sludge system. The volume ratios are typically 1:2:17. The manner in which the oxygenation regime and redox potential can be controlled so that both the anoxic and an aerobic conditions essential to nutrient removal are created is outlined, followed by an account of the operation of installations at Portage/Catawba Island, Ohio, and Dundee, Michigan, both of which are capable of operating at very low temperatures, the former basins reaching fluctuating between 25°C and 4°C according to season. The actual discharge flow can be rendered more uniform in time by the operation of 2 units side by side. **U.S.A.**

95-1860\*

**Nutrient removal from wastewater in activated sludge and biofilm reactors.**

P. HARRÉMOES (Denmark Technical University, Lyngby)

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.

Factors governing the application of deterministic models to the operation of suspended biomass and fixed film biological systems for the removal of organic matter and nutrients from municipal wastewaters are reviewed. The characterization of the influent, including its composition and flow rate, and any fluctuations in time are essential to a reliable approach to the modelling process, together with a knowledge of the relevant kinetic constants and their variation due to extraneous factors and the presence of inhibitory substances. The manner in which such a complex problem can be simplified is outlined, assisted by the operation of model reactor systems utilizing the influent under consideration. The manner in which nitrification varied in response to changing conditions including the influence of holiday periods at the Copenhagen sewage plant is described followed by a consideration of the progress of denitrification in a fixed film bioreactor, taking into account biofilm thickness and the dissolved oxygen content in the bulk aqueous phase. **Denmark**

## 95-1861\*

**Full scale demonstration of biological nutrient removal using the intermittently decanted extended aeration system.**

S. HARRIS (NSW Public Works, Sydney) and W. BATTYE-SMITH

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. The nature of the intermittently decanted extended aeration (IDEA) process for biological nutrient removal in small-scale activated sludge systems is outlined involving the addition of recirculation and an anoxic/anaerobic zone at the plant inlet. The results of studies performed on a 150 PE pilot plant with normal flow and loading fluctuations were used as the basis for design of a demonstration plant of 4000 PE rated capacity at Bathurst, N.S.W. Diagrams showing the plant configuration are presented together with operating results for the last 3 months of the pilot plant studies. These indicated that a treated effluent containing less than 1 mg total phosphorus per litre and less than 10 mg total nitrogen per litre could be obtained. **Australia**

## 95-1862\*

**Commissioning of the full-scale biological nutrient removal plant at St. Marys, N.S.W.**

D. MARIS (Waterboard, Sydney Illawarra Blue Mountains)

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. An account of the commissioning and initial performance of the full scale BNR sewage treatment plant for St. Marys, N.S.W. (50 000 PE rated capacity) is presented. The plant was designed with anaerobic compartments in series, 4 sequential anoxic compartments and a plug flow aeration zone together with provision for nitrification and sludge fermentation and a return activated sludge denitrification compartment. Effluent with low concentrations of suspended solids, BOD and ammonium nitrogen was rapidly obtained but nitrification did not become established until about 1 month after start up. Biological phosphorus removal was also slow to develop and total phosphorus concentrations in the final effluent only fell below 4 mg per litre when the sludge age was decreased to 5 d. Dosing of the clarifier effluent with small amounts of spent pickling liquor was required to lower this level below 2 mg per litre with only a negligible effect on the effluent pH. **Australia**

## 95-1863

**Performance and model calibration of R-D-N processes in pilot plant.**

A. de la SOTA (Consorcio de Aguas de Bilbao Sestao), I. LARREA, I. NOVAK, P. GRAU and M. HERNIZ

*Water Science & Technology*, 1994, 30, No 6, 355-364

An advanced biological nutrient removal process treating Bilbao domestic wastewater at pilot scale was investigated experimentally. In the first phase of the study, the R-D-N process was tested over an 8 month period at 3 temperatures (20, 15 and 11°C). In quasi-steady state conditions, the ammonia concentration in the effluent was in the range 1-5 mg nitrogen per litre. Partial inhibition of nitrification was observed at certain periods. Effluent nitrate concentrations varied in the range 10-12 mg nitrogen per litre. The anoxic selector and the regeneration zone were configured to ensure an appropriate balance between floc-forming and filamentous micro-organisms. The IAWPRC No.1 model was calibrated to the process. **Spain**

## 95-1864

**Beckton demonstration biological nutrient-removal plant.**

S. WILLIAMS (Thames Water Utilities R and D, Reading) and A. W. WILSON

*Journal of Institution of Water and Environmental Management*, 1994, 8, No 6, 664-670

The demonstration-scale biological nutrient removal facility, constructed by Thames Water at Beckton sewage treatment works to provide operational experience of nutrient removal and accurate design and cost information, is described. The principles of biological nutrient removal are outlined. The facility design and layout are described and results from the first 3 months operation are presented. The configuration chosen was the Johannesburg modified 3 stage Bardenpho process. Differences in operating conditions during periods of poor and good performance are examined. The facility had removed over 50 per cent of both nitrogen and phosphorus present in the settled sludge but had not met consistently the EC Directive standards for urban wastewater treatment. Future process improvements and modifications are discussed. **U.K.**

## 95-1865\*

***Acinetobacter* and enhanced biological phosphate removal.**

R. C. BAYLY (Monash University, Clayton, Vic.) G.

DUMSDAY, G. VASILIADES, A. WOODS and J. W. MAY

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.

There have been numerous reports confirming the involvement of *Acinetobacter* in enhanced biological phosphorus removal processes for use in biological wastewater treatment to comply with stringent effluent quality standards. There has also been much speculation about the possible involvement of other organisms, fuelled by the results of laboratory experiments in which the observed behaviour of *Acinetobacter* cultured in the laboratory differed from that of the biomass. Some results of phosphate release/acetate uptake studies under anaerobic conditions using pure cultures of *Acinetobacter* are presented, together with studies of the role of poly-beta-hydroxybutyrate in the accumulation of polyphosphates under laboratory conditions. Some of the apparent anomalies concerning the uptake of phosphate by *Acinetobacter* disclosed by such studies are considered and the desirability of further experimental work on this species is open to question. **Australia**

## 95-1866\*

**Ability of the two-stage biological phosphorus removal system to treat variable strength waste**

S. M. CROSHER (Melbourne Water) and I. K. HARDING

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.

The treated effluent from the Pakenham sewage treatment plant, Melbourne, must comply with a mean effluent total phosphorus limiting value of 1 mg per litre by 1997 and investigations were performed to assess the feasibility of achieving this by biological nutrient removal based on a 2 stage anaerobic/aerobic version of the existing activated sludge process. This was capable of achieving a soluble phosphorus concentration of 0.5 mg per litre in the treated effluent especially during midweek periods. However, low sludge ages required to inhibit nitrification and loss of COD in the anaerobic compartment caused the formation of pin flocs and high solids contents in the effluent at week ends. These increased the total phosphorus concentration to 2 mg per litre. For satisfactory performance a COD/total phosphorus ratio of over 50 was necessary coupled with good aeration control and dense floc formation. These criteria

## SEWAGE

could not be met during the weekends when the proportion of industrial inputs fell sharply. Consequently some additional measures such as chemical treatment might need to be introduced.

Australia

### 95-1867\*

#### **Phosphate removed by *Acinetobacter* species isolated from activated sludge.**

G. J. DUMSDAY (Monash University, Clayton, Vic.), G. VASILIADES, D. Di BERARDINO, R. C. BAYLY and J. W. MAY

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference, Albury, N.S.W.* The possibility of using cultures of *Acinetobacter* in a stand alone bioreactor for the removal of phosphate at the end of the sewage treatment chain was evaluated. A number of *Acinetobacter* strains were isolated from pilot scale sewage treatment systems exhibiting enhanced biological phosphorus removal and these were tested under conditions representative of the outlet from the secondary treatment stage. Their ability to remove dissolved phosphate was markedly correlated with their capacity for polyphosphate synthesis under balanced growth conditions, one particular strain (RA3117) being especially effective. The effect of a number of extraneous factors on phosphorus uptake by this organism was examined, including carbon source, dissolved oxygen level and temperature. Both ethanol and acetate were effective as carbon and energy sources for phosphorus removal by this strain and lowering the DO concentration to 1 per cent of saturation had no effect on the rate of phosphorus removal. However, lowering the temperature produced a marked deterioration in the phosphorus uptake performance. The organism thus appeared to fulfill the principal criteria for use in a stand alone bioreactor. **Australia**

### 95-1868

#### **Biological phosphate removal in a sewage treatment plant of the activated sludge type with very low organic loading.**

K. WOUTERS, WASIAK (CIMAGRE), A. HEDUIT, P. CORLAY, J. EHSTAND and J. M. ALDIC

*Techniques, Sciences, Methodes* 1994, **89**, No 11, 625-629 (in French, English summary)

The operation of the sewage treatment plant for the village of Bavilliers (population 15 000) was modified by the inclusion of an anaerobic zone at the inlet to the aeration tank permit the process of biological phosphorus removal to be studied. The sewage entering the treatment plant was very dilute (BOD5 approximately 150 mg per litre) on account of the high proportion of laundry effluent from a psychiatric hospital in the vicinity, and the treatment plant was operated under conditions of very low organic loading rates (0.04 kg BOD per kg sludge solids d<sup>-1</sup>). The plant layout also enabled both nitrification and denitrification reactions to occur to an appreciable extent on account of the low sludge loading and the presence of an anoxic zone for denitrification. Measurements of the concentration of total phosphorus in the treated effluent are reported which showed that around 40 per cent of the incoming phosphorus was being removed in the biomass, a proportion appreciably higher than that normally achieved (20 per cent) by the classical activated sludge system. The treated effluent concentrations varied between 2 and 6 mg per litre. The redox potential (minus 50 mV) appeared to be a useful control parameter for the phosphorus removal stage. (English translation 130 pounds sterling valid for 1995). **France**

### 95-1869

#### **Genetic approach to enhanced biological phosphorus removal.**

H. OHTAKE (Hiroshima University), K. YAMADA, HARDOYO, A. MURAMATSU, Y. ANBE, J. KATO, and H. SHINJO

*Water Science & Technology* 1994, **30**, No 6, 185-192

*Escherichia coli* was used as a test organism in studies of the feasibility of genetic improvement of bacterial ability to accumulate phosphate. High levels of accumulation were obtained by modifying genetic regulation and increasing the dosage of the *E. coli* genes encoding polyphosphate kinase, acetate kinase and the phosphate inducible transport system and by inactivating the gene encoding exopolyphosphatase. The best recombinant strain accumulated approximately 10 times as much phosphate as the control strain. The phosphorus content of the strain reached a maximum of 16 per cent on a dry weight basis. About 65 per cent of the cellular phosphorus was stored as polyphosphate. **Japan**

### 95-1870

#### **Effect of the anaerobic solids retention time on enhanced biological phosphorus removal.**

Y. MATSUO (Chuo University, Tokyo)

*Water Science & Technology* 1994, **30**, No 6, 193-202

Continuous flow enhanced biological phosphorus removal systems were used to investigate the effects of varying the anaerobic solid retention time (SRT) on phosphate removal. With a short anaerobic SRT, phosphorus removal in the system declined due to the growth of non-phosphate accumulating microorganisms which competed in anaerobic substrate uptake with polyphosphate accumulating bacteria. By extending the anaerobic SRT, however, phosphorus removal was enhanced. A long anaerobic SRT helped the polyphosphate accumulators to compete for substrate with other heterotrophs which were capable of anaerobic substrate uptake. **Japan**

### 95-1871

#### **Deterioration of enhanced biological phosphorus removal by the domination of micro-organisms without polyphosphate accumulation.**

H. SATOH (Tokyo University), T. MINO and T. MATSUO

*Water Science & Technology* 1994, **30**, No 6, 203-211

The failure of an enhanced biological phosphorus removal system was investigated. Microbial metabolism in sludge from the failed system was studied to identify the causes of the breakdown. The sludge did not accumulate polyphosphate, but absorbed acetate and propionate in anaerobic conditions. It obtained energy for substrate uptake in anaerobic conditions by converting glycogen to polyhydroxyalkanoate via acetyl CoA and propionyl CoA, rather than by the hydrolysis of polyphosphate. Strategies for avoiding the accumulation of microorganisms with this undesirable metabolism and the resulting failure of biological phosphorus removal are considered. **Japan**

### 95-1872

#### **The effect of fermentation products on enhanced biological phosphorus removal, polyphosphate storage, and microbial population dynamics.**

A. A. RANDALL (Central Florida University, Orlando), L. D. BENFIELD and W. E. HILL

*Water Science & Technology* 1994, **30**, No 6, 213-219

The effect of pre-fermentation of influent glucose on enhanced biological phosphorus removal was investigated using anaero-

hic/aerobic sequencing batch reactors (SBR). Fermentation products, particularly carboxylic and dicarboxylic acids, induced and maintained the phosphorus removal process. This ability might result from the steady-state population selected for when these substrates were present, together with their role as precursors of storage products such as polyhydroxyalkanoates formed during anaerobiosis in phosphorus removal systems. An anaerobic/aerobic SBR receiving starch rather than glucose fermentation products showed only marginal enhanced biological phosphorus removal. U.S.A.

95-1873

**Induction method of excess phosphate accumulation for phosphate removing bacteria isolated from anaerobic/aerobic activated sludge.**

Y. UBUKATA (Tokyo Metropolitan University) and S. FAKI. *Water Science & Technology* 1994, 30, No 6, 221-227.

The hypothesis that the enzyme system responsible for excess phosphorus accumulation in phosphate removing bacteria should be inducible was examined. A strain of true phosphate removing bacteria was isolated by subjecting cells grown aerobically to alternating anaerobic incubation with organic substrates and aerobic incubation without organic substrates. The isolate was a Gram positive coccus with a generation time of approximately 12 h. The anaerobic/aerobic incubation cycle had to be carried out at least twice to induce excess phosphorus accumulation in phosphate removing bacteria. The phosphorus content of the isolate was 5.7 per cent (phosphorus/cell dry weight). Japan.

95-1874

**Dynamics of phosphorus and organic substrates in anaerobic and aerobic phases of a sequencing batch reactor.**

A. CARUCCI (University La Sapienza, Rome), M. MAJONE, R. KAMADORI and S. ROSSETTI.

*Water Science & Technology* 1994, 30, No 6, 237-246.

Enhanced biological phosphorus removal was studied in a laboratory scale sequencing batch reactor. A synthetic feed based on peptone and glucose was used to simulate the readily biodegradable fraction of a municipal wastewater. The phosphorus removal efficiency was much higher in the absence of competition for organic substrate between phosphorus accumulating and denitrifying bacteria. The activated sludge consisted largely of the class of bacteria named G bacteria by previous researchers. The assumption that the G bacteria were characterized by anaerobic substrate uptake unconnected with polyphosphate metabolism was not borne out by the study. Italy.

95-1875

**Interactions between biological and physico-chemical mechanisms in biological elimination.**

P. C. WITT (Karlsruhe University), E. GRABOWSKI and H. H. HAHN.

*Water Science & Technology* 1994, 30, No 6, 271-279.

The involvement of physico-chemical mechanisms in biological phosphate elimination processes was examined. Batch experiments and a sequential phosphorus extraction were carried out. The results of the batch experiments showed that both calcium and magnesium participated in biologically mediated phosphate precipitation. Sequential fractionation confirmed the existence of particulate physico-chemically bound phosphorus whose involvement in phosphate uptake and release should not be neglected. Both types of experiment showed that physico-chemical mechanisms took part in enhanced biological phosphate removal and should be taken into account in deterministic model development. Germany.

95-1876

**Phosphate release of sludges from enhanced biological P-removal during digestion.**

N. JARDIN (Darmstadt University of Technology) and H. J. POPEL.

*Water Science & Technology* 1994, 30, No 6, 281-292.

The amount of phosphorus eliminated during wastewater treatment and subsequent releases during anaerobic sludge digestion were investigated in the course of the start-up phase of an enhanced biological phosphorus removal system. A strong correlation between the potassium, magnesium and phosphorus content of the sludge and results gained from phosphorus fractionations indicated that the greater part of the eliminated phosphorus was stored in the form of polyphosphate. The soluble potassium concentration seemed to provide a good measure of the amount of phosphate released. Calcium dosing experiments showed that calcium phosphate precipitation played only a minor role in phosphate fixation. Germany.

95-1877

**Circulation of phosphorus in a system with biological P-removal and sludge digestion.**

U. NYBERG (Malmo Water and Sewage Works), H.

ASPEGREN, B. ANDERSSON, P. FLBERG, JORGENSEN and

E. LA COUR JANSEN.

*Water Science & Technology* 1994, 30, No 6, 293-302.

Enhanced biological phosphorus removal based on an activated sludge process was studied at pilot scale at the Sjolunda works, Malmo, over an extended period. Particular attention was given to the operation of the sludge treatment system. Fractionation procedures were carried out to characterize the sludge with respect to phosphorus. The influent wastewater quality determined the release and precipitation of phosphorus during anaerobic digestion. The potential for precipitation was strongly influenced by the quantity of metals in the influent wastewater which were removed with the wasted sludge. Biologically bound phosphorus was partially transferred to a metal bound state during anaerobic digestion. Sweden.

95-1878

**Influence of the addition of precipitants on the biological phosphorus elimination in a pilot plant.**

I. ROSKE (Dresden University of Technology) and C. SCHONBORN.

*Water Science & Technology* 1994, 30, No 6, 323-332.

A biological phosphorus elimination process treating mechanically pretreated domestic sewage was operated at bench scale. The system consisted of anaerobic and aerobic tanks and a clarifier, and was operated with and without the addition of precipitants. X-ray spectra of polyphosphate granules showed that polyphosphates were associated with calcium or with magnesium and potassium. Magnesium and potassium were released in the anaerobic tank and taken up in the aerobic tank in parallel with phosphorus. Calcium, however, remained immobile. The addition of 3 mg iron precipitant per litre did not affect biological phosphorus removal, though it increased the amount of chemically bound phosphorus in batch experiments. Germany.

95-1879

## Prediction of the performance of enhanced biological phosphorus removal plants.

M. MAUREK (Swiss Federal Institute for Environmental Science and Technology (EAWAG), Dübendorf) and W. GIER. *Water Science & Technology* 1994, 30, No 6, 323-343.

A simple static mathematical model was developed for the prediction of the performance of enhanced biological phosphorus removal systems in a wide variety of steady state operating conditions. The model was based on the observation that phosphorus accumulating organisms released phosphorus and stored organic substrates in anaerobic conditions while storing phosphorus in the form of polyphosphates in aerobic conditions. Model predictions were based on wastewater composition, operating temperature, the effect of oxygen and nitrate addition to the anaerobic reactor, solids retention time and the fraction of anaerobic mass in the activated sludge.

Switzerland

95-1880

## Modelling of the Carrousel plant.

J. DERCO (Chemical Technology Faculty, Bratislava), M. KRAJČIK, M. HUČNAN, I. BODÍK, and R. ČERNÁK. *Water Science & Technology* 1994, 30, No 6, 345-354.

Mathematical models describing the dynamics of simultaneous nitrification and denitrification processes taking place in a Carrousel oxidation ditch system were developed and verified. At least 3 types of model: a tank in series model, an ideally mixing reactor model with aerobic and anoxic zones, and a completely mixing reactor model with intermittent aeration, were suitable to describe the behaviour of this type of reactor. The simplest model used the completely mixing, intermittently aerated reactor concept, with switching function values obtained by direct evaluation of dissolved oxygen profiles in the bioreactor, to simulate the dynamic behaviour of the system. **Slovak Republic**

95-1881

## Sizing storm-water detention basins for pollutant removal.

G. V. LOGANATHAN (Virginia Polytechnic Institute and State University, Blacksburg), F. W. WATKINS, and D. T. KIBLER. *Journal of Environmental Engineering* 1994, 120, No 6, 1380-1399.

For detention ponds to work as best management practices (BMP) and prevent pollutant loads from being transported downstream, it is necessary to capture the pollutant load from the runoff by the pond and to prevent the pollutant load from leaving the pond. A statistical formulation is described for estimating the average time of detention within a pond for a captured runoff volume. It provides an explicit closed-form solution for the expected detention time under an random sequence of runoff events. The relationship between pollutant settling efficiency and detention time was determined. The determination time was used in conjunction with the pollutant-settling efficiency-detention time curve to estimate settling efficiency. Computer experiments with the U.S. EPA Stormwater Management Model (SWMM) computer program supported the use of the detention time as an effective parameter in assessing the pollutant settling efficiency within the pond. Two numerical examples are presented. **U.S.A.**

95-1882

## Utilization of ferruginous waterworks sludges for phosphate removal.

S. THOLE (T.U. Berlin), S. MARTIN, and M. JEKEL.

*Korrespondenz Abwasser* 1994, 41, No 11, 2024-2026 and 2028 (in German, English summary).

The feasibility of using waterworks sludge containing appreciable amounts of iron as a coagulant for the removal of phosphate from secondary sewage effluent was investigated as part of a government sponsored project. The rate of introduction of the sludge was varied within wide limits, a maximal iron dose rate of 0.4 kg per m<sup>3</sup> being employed, corresponding to a range of iron/phosphorus ratios of up to 20. Laboratory studies showed that the addition of sludge was effective in removing 90 per cent of ortho-phosphate and 70 per cent of total-phosphate from the settled sewage at an iron/phosphorus ratio of 10. Since phosphate is required as a nutrient for the growth of biomass, a smaller addition of the same sludge at the primary settling stage was sufficient to give a phosphorus content in the final effluent which complied with the effluent quality standard of 1 g per m<sup>3</sup>. Satisfactory results were also obtained from the addition of sludge to the aeration tank (simultaneous coagulation), although the suspended solids concentration was thereby increased considerably such that a level of 77 g iron per m<sup>3</sup> was equivalent to an additional residual solids content of 170 g per m<sup>3</sup>. Further studies also indicated that the use of waterworks sludge helped to stabilize the process of biological phosphate removal. (English translation 165 pounds sterling, valid for 1995). **Germany**

95-1883

## Post-coagulation using hydrated lime.

P. BAUMANN (Universität Stuttgart), K. KRAUTH, and G. WERNER.

*Korrespondenz Abwasser* 1994, 41, No 12, 2232-2241 (in German, English summary).

The method of post coagulation as a means of complying with stringent final effluent quality standards, such as less than 0.5 mg per litre for total phosphorus, was evaluated. A series of laboratory and pilot plant trials. Hydrated lime suspensions were dosed into a rectangular axial flow coagulation tank, and the effects of pH and residual calcium content on the final phosphorus concentration were investigated. Satisfactory final effluent total phosphorus contents were achieved by operating at pH 10.2, and this was accompanied by a considerable improvement in other quality parameters, e.g. residual COD, turbidity, filterable solids and colour in the treated final effluent after sedimentation. The additional costs of 0.08-0.22 DM per m<sup>3</sup> were considered relatively slight. The resulting tertiary sludge consisted of a mixture of calcium carbonate and phosphates and could be used as a fertilizer without a significant additional cost penalty. There are 39 references. (English translation 305 pounds sterling, valid for 1995). **Germany**

95-1884

## Use of dual precipitation for phosphate removal and sludge ballasting at the Forchheim sewage plant: effects on nitrification, nitrogen removal, COD-reduction and hydrogen sulphide fixation.

K. KULICKE (Sud-Chemie AG, Freising) and S. PETZL.

*Korrespondenz Abwasser* 1994, 41, No 12, 2269-2274 (in German, English summary).

Trials were carried out at the Forchheim sewage treatment plant (120,000 PE) using the proprietary coagulant Sudflock K2 as a means of phosphate precipitation by dosing it into the feed to the

primary settling tank and also into a turbulent zone at the outlet from the aeration tank. The coagulant was in the form of a liquid containing a mixture of ferric aluminium, calcium and magnesium ions in acid solution together with fine particles of bentonite obtained as a byproduct from the production of fullers earth in Bavaria. The sewage being treated contained a high proportion of industrial effluent giving rise to very loosely knit sludge flocs. Tests were performed to optimize the dosage rate and showed that a final effluent content of 1 mg total-phosphorus per litre could be maintained while the precipitate resulted in a marked increase in sludge settling velocity and also an increased BOD5 removal at the primary settling stage. The nitrification performance was also increased as a result of the reduced BOD sludge loading rate and in addition there was a drastic reduction in the hydrogen sulphide content of the digester gas from 740 mg per m<sup>3</sup> to around 80 mg per m<sup>3</sup>. (English translation 220 pounds sterling valid for 1995) **Germany**

#### 95-1885\*

##### **Removal of phosphorus from trickling filter effluent using ferric chloride and alum - pilot studies**

J. CHONG (CMPS&I Environmental Melbourne Vic.) and J. SMITH

*Second Australian Conference on Biological Nutrient Removal from Wastewater*. Proceedings BNR2 Conference, Albury NSW. A reduction in the total phosphorus concentration in the effluent discharged by the Moe sewage treatment plant (20 000 PE) was demanded by the Victoria pollution control authorities from levels of around 5 mg per litre to only 1 mg per litre maximum or a mean value of 0.5 mg per litre. This could most readily be achieved by coagulant dosing at the outlet from the trickling filter, using either alum or ferric chloride. Trials with these chemicals in conjunction with lime were carried out on a pilot scale and showed that a clear supernatant could be obtained having a phosphorus content of less than 1 mg per litre using either ferric chloride and lime or alum and lime. The solids concentrations of both types of sludge were low and a relatively large volume of settled sludge was produced. Ferric chloride was the preferred chemical in terms of treatment efficiency but the cost was more than twice that of alum dosing. **Australia**

#### 95-1886\*

##### **Chemical phosphorus removal at Brushy Creek local treatment plant.**

D. A. COLEMAN (Melbourne Water Corporation, Binghamline Vic.)

*Second Australian Conference on Biological Nutrient Removal from Wastewater*. Proceedings BNR2 Conference, Albury NSW. The results of a series of trials with different coagulants and dosing points at the Brushy Creek sewage treatment plant (43 000 PE) in a north eastern suburb of Melbourne, Vic. are reported as a means of reducing the treated effluent concentration of total phosphorus to less than 2 mg per litre. The coagulant consisted of ferric chloride in conjunction with lime, spent pickling liquors and alum injected at different points. From an analysis of the results taking into account the mass of sludge produced and the sludge settling characteristics, ferric chloride was the most promising coagulant but on cost grounds ferrous chloride was adopted for large scale trials, the solution being injected into the raw sewage in a manner which ensured its oxidation to ferric chloride. Using this method the required phosphorus concentration 2 mg per litre was complied with the lowest value being 0.2 mg per litre during a 3 month trial period. The use of spent pickling liquor as the coagulant caused a

major reduction in the amount of caustic soda required for pH correction. **Australia**

#### 95-1887

##### **Study on phosphorus removal using a new coagulation system.**

W. XIE (Best Industries Inc. Osaka) M. KONDO and Y. NAITO

*Water Science & Technology* 1994, 30, No 6, 257-262

The design of a coagulation filtration system for high phosphorus removal efficiency was studied. The filter media examined were sand of 0.6 mm diameter, anthracite of 1.2 mm diameter and a mixture of both. The 2 medium filter bed proved to be superior in terms of pressure drop and breakthrough. Continuous operation for more than 20 h was possible. Blocking of the filter bed could be overcome by backwashing. A phosphorus removal efficiency of 80 per cent was achieved with a linear velocity of less than 5.0 m per h when the powdered activated carbon dose was controlled so that the aluminium/phosphorus molar ratio was 3.0 for the initial period and approximately 2.0 thereafter. **Japan**

#### 95-1888

##### **Denitrification and neutralization with an electrochemical and biological reactor**

Y. SAKAKIBARA (Gunma University) K. ARAKI, T. TANAKA, T. WATANABE and M. KURODA

*Water Science & Technology* 1994, 30, No 6, 151-155

Denitrifying micro organisms were immobilized on a stainless steel cathode using a sodium alginate gel. An electric current was applied using a carbon electrode as the anode. Biological reduction of nitrate took place at the cathode through the use of hydrogen generated there. The formation of inorganic carbon compounds was observed at the anode. The oxidation of the carbon electrode to carbon dioxide was favourable to the development of anoxic conditions and the neutralization of alkalinity formed as a result of denitrification. The electrical energy needed to remove 10 mg nitrogen per litre was about 0.22 kWh per m<sup>3</sup> using the carbon and stainless steel electrodes. **Japan**

#### 95-1889

##### **Elimination of bacteriological indicator organisms and heavy metals during treatment of domestic sewage in a semi-industrial pilot plant**

A. HASSEN (URNE Eau Tunis) N. JEDIDI, H. KALLEL, M. ELRICHCHI, A. GHIRABI, F. CHIBBI, A. CHEHAÏ, N. SAIDI, H. SHAYIB and M. ENNABI

*Sciences et Techniques de l'Eau* 1994, 27, No 4, 34-41 (in French, English summary)

The results of a series of experiments are reported in which the capability of different methods of treatment of domestic sewage was assessed with respect to the quality of the final effluent and its suitability for reuse in crop irrigation schemes. The effect of natural lagooning (stabilization pond) treatment was to reduce the level of bacterial contamination by 3-4 log units but the high concentration of algae in the treated effluent was unacceptable while the sludge exhibited satisfactory low levels of heavy metals but a high bacterial count for the relevant organisms. Slow sand filtration generally gave effluents of good bacteriological quality but problems of clogging of the filter bed and non uniform distribution over the filter surface remained. Disinfection using sodium hypochlorite appeared to be effective when applied to settled secondary effluents given a contact time of 10 minutes at 1.3 mg chlorine per litre while very promising results were obtained from UV irradiation with contact times of

## SEWAGE

around 1.5 seconds (English translation 285 pounds sterling valid for 1995) Tunisia

### 95-1890\*

#### **Removal of nutrients from secondary treated wastewater effluent using natural zeolite.**

S. KOMAROWSKI (Griffith University Qld) Q. YU, P. JONES, and A. MACDOUGALL

*Second Australian Conference on Biological Nutrient Removal from Wastewater. Proceedings BNR2 Conference, Albury, N.S.W.* Results obtained from bench-scale equilibrium and kinetic studies of the extent of nitrogen and phosphorus removal from secondary sewage effluent by natural zeolite additions are reported. The powdered zeolite, obtained from Mt. Coppins in Vic., Australia, was added in amounts ranging from 2 to 50 g per litre and the levels of ammonia, nitrate and nitrite, orthophosphate and total phosphorus remaining in the aqueous phase were determined once equilibrium had been attained. The data indicated a significant degree of ammonium nitrogen reduction (up to 62 per cent) while the reduction in the level of phosphorus was much lower (approximately 15 per cent). Kinetic experiments using effluent and ammonium chloride solutions indicated that equilibrium was reached after 2 h. The ammonia removal efficiency in contact with the pure solution being greater than when secondary effluent was used, as the ammonia exchange capacity was reduced by the presence of competing ions. Australia

### 95-1891

#### **Evaluation of four different tertiary filtration plants for turbidity control.**

J. F. KUO (County Sanitation Districts of Los Angeles County, Whittier, Calif.), C. T. CHIN, J. E. STAHL, and R. W. HORVATH

*Water Environment Research*, 1994, **66**, No 7, 879-886

Four types of tertiary filtration systems were operated at 7 of the County Sanitation Districts of Los Angeles County's water reclamation plants. These were mono-medium gravity filters (activated carbon or anthracite coal), dual-media gravity filters, and dual-media pressure filters. The performance of the filters was evaluated and compared. All 4 types of filters met California's turbidity limit of 2 NTU, despite differences in turbidity removal efficiencies. The ratios of suspended solids to turbidity were determined and were similar in the different systems. The activated carbon filters showed the highest turbidity and suspended solids removal efficiencies. The average values of particle counts of the secondary effluents and filter effluents were 3570, 5690 and 850, 1780 particles per ml, respectively. Values of the power-law coefficient were 2.49, 2.9 and 3.05, 3.41 for the secondary effluents and filter effluents, respectively. With the exception of the dual-media gravity filter effluent, the filter effluents were free of particles larger than 50 µm. U.S.A.

### 95-1892

#### **A filtration technique for algal removal from lagoon effluents.**

D. D. TRUAX (Mississippi State University) and A. SHINDAL, A. *Water Environment Research*, 1994, **66**, No 7, 894-898

Post-treatment filtration techniques for algal removal from facultative lagoon effluents were evaluated at Starkville South Lagoon, Miss., U.S.A. Eight intermittent sand filters were constructed with 4 different sand sizes. The optimal construction was the medium with an effective size of 0.18 mm which had a uniformity coefficient of 2.7. When loaded at 0.2 m<sup>3</sup> per m<sup>2</sup> d, this medium produced an effluent averaging 13.6 and 4.3 mg per litre for volatile suspended solids, BOD and total Kjeldahl nitrogen, respectively. Average ef-

fluent total coliform count averaged 38,000 organisms per 100 ml, indicating that disinfection of secondary effluent was necessary. Intermittent sand filter performance and run length were affected by grain size distribution and hydraulic loading rates. U.S.A.

### 95-1893

#### **The lateral-flow sand-filter system for septic-tank effluent treatment.**

G. G. CHECK (Jacques Whitford Environment Ltd, Dartmouth, N.S.), D. H. WALLER, S. A. LEE, D. A. PASK, and J. D. MOOERS

*Water Environment Research*, 1994, **66**, No 7, 919-928

The lateral flow sand filter (LFSF) is an alternative to ordinary on-site wastewater soil disposal systems where natural soils are of low permeability or provide a thin cover above bedrock. LFSF bio-mat development, septic tank effluent treatment quality and hydraulic conditions were evaluated in 3 full-size laboratory models with different permeability sand fill. The models were dosed with septic tank effluent for 6 months. The models containing the finest, least permeable sands developed significant bio-mats. The coarsest, most permeable sand showed no bio-mat development. BOD and total carbon removals of over 99 and 86 per cent, respectively, were achieved. Nitrification in the models developed over the 3-month period. There are 31 references. Canada

### 95-1894

#### **Nutrient removal using cyanobacteria (*Phormidium bohneri*): experimental results with a batch reactor.**

P. LESSARD (Université Laval, P.Q.), D. PROULX, and J. de la NOUE

*Water Science & Technology*, 1994, **30**, No 6, 365-368

The feasibility of using the cyanobacterium *Phormidium bohneri* to remove nutrients from a secondary municipal effluent was investigated using a 500 litre reactor operated in batch mode. To ensure uniform light exposure of all cyanobacteria, biomass mixing was carried out by aeration. The treatment potential and dynamic behaviour of the process were determined during a batch experiment. Satisfactory nutrient removal by cyanobacterial biomass was achieved, confirming the viability of the process as a tertiary treatment process for small communities. Further study was required on ammonia stripping mechanisms, precipitation of phosphate and system modelling and optimization. Canada

### 95-1895

#### **Hygienic upgrading of treated sewage using vegetative soil filters.**

T. GRADL (Toni Gradl & Partner, Sankt Englmar) and A. LEINZ, *Korrespondenz Abwasser*, 1994, **41**, No 12, 2250-2252 (in German, English summary)

A small pilot plant biofilter was constructed from a water butt of approximately 2 ft diameter filled with several layers of gravel (coarse and fine) topped with a mixture of sand, peat and loamy soil and was supplied with secondary sewage effluent at a rate of 2.5 m<sup>3</sup> per d. The effluent was applied intermittently to the soil surface which was planted with specimens of calamagrostis (*Acorus calamus*), an aromatic shrub, the essential oils of which were known to have antiseptic properties. The oil is stored in the rhizomes and consists of a mixture of terpenes, sesquiterpenes and phenolic compounds. The bacterial counts of the influent and effluent were recorded at regular intervals over a 12-month period and demonstrated that considerable reductions in the counts of total and faecal coliforms occurred during passage through the filter, such that the filtered

effluent was similar in its bacteriological quality to the levels prescribed for outdoor swimming pools. Similar trials in which a filter of similar type was planted with *Phragmites* achieved less satisfactory reductions in bacterial counts and a poorer treated effluent quality. The cost of vegetative filter treatment was estimated as only about 0.03 DM per m<sup>3</sup> or about 30 per cent of that of UV irradiation (English translation 85 pounds sterling, valid for 1995). Germany

#### 95-1896\*

##### **Recent developments in the use of constructed wetlands for nutrient removal.**

H. J. BAVOR (Western Sydney University, Richmond, N.S.W.) and D. J. ROSER

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. A general review of the purposes for which constructed wetlands may be employed within the overall context of sewage or effluent treatment is presented, together with some empirical guidelines on their design, such as the kinetic equations linking the concentration reduction of organic matter with the retention time in the wetland. A brief discussion of the various forms of plants and their capabilities for sustaining the purification of the wetland is also included. Australia

#### 95-1897\*

##### **SWAMP: a computerized decision support system for employing constructed wetlands in the biological removal of nutrients and other water pollutants.**

D. J. ROSER (Western Sydney University, Richmond, N.S.W.) and H. J. BAVOR

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. The development and potential uses of the Simulated Wetland Analysis and Modelling Programme (SWAMP), consisting of a computer-based decision support system for artificial wetland construction are described. The prototype version was being used to assist in assessing the feasibility of several proposed wetland projects, and for the testing of various design options. It allowed the compilation of various subsets of data relating to effluent quality, such as BOD, suspended solids, ammonium nitrogen and total Kjeldahl nitrogen and total phosphorus from previously published work, and was also capable of being updated in the light of newly acquired results. The programme could be used to assess the economic viability of wetland systems for nutrient removal, and to determine the land area required for a given combination of hydraulic and climatic conditions. Modelling of evapotranspiration rates had shown that high evaporation rates rather than scarcity of land might restrict the size of wetlands in arid areas with high daytime temperatures. Australia

#### 95-1898

##### **Cold weather wetlands constructed.**

R. THORSON (Town of Platteville, Colo.), W. LORENZ and R. ARBER

*Water Environment & Technology*, 1994, 6, No 12, 25-26. A wastewater treatment system relying on a wetland environment installed in a town near Denver, Colo., was being closely monitored by the State's Department of Health and Environment as a pilot scheme for possible application elsewhere. The treatment system comprised 2 aerated lagoons followed by a passive lagoon; in the latter, algal growth and die-back in the summer gave high suspended solids and BOD to the water. To counter biomass production, the

passive lagoon was planted with the wetland plant cat tails, whose height above the water surface of up to 2 ft helped to exclude light from the algae, thereby slowing their growth. Under summer conditions, the suspended solids concentration of the inflow to the wetland (58 mg per litre) was reduced to 18 mg per litre at the outflow, and BOD from 32 to 19 mg per litre. Although cat-tails would die back in winter, algal growth would be correspondingly reduced, it would, however, be unrealistic to rely on biological uptake in such an open system where year-round nutrient removal before discharge to a watercourse was required. U.S.A.

#### 95-1899

##### **Land application turns wastewater into ice cubes.**

M. MADISON (CH2M Hill, Portland, Ore.) and M. HENDERSON

*Water Environment & Technology*, 1994, 6, No 12, 33-34

An agricultural technique permitting the year-round application of a reclaimed wastewater to land, which has proved successful during 2 winters on the North American plains, is described. Winter crops such as turnips and winter wheat were drilled into the soil as usual, but the drill carried an auxiliary device known as a dammerdiker. This created a series of waffle-like depressions, at a rate of approximately 10 000 depressions per acre, each holding approximately 1 gallon. Reclaimed wastewater could be sprayed from a conventional irrigator, whose droplet size could be varied by altering the discharge orifice diameter. Under freezing conditions, and when the droplet was suitably sized, the water would freeze before it reached the ground, and formed a loosely compacted snow. Assuming daylight temperatures were sufficient, these ice crystals melted into the depressions and would later re-freeze. Spring snowmelt was gradual with minimal run-off. Soil moisture monitoring was conducted, to ensure that no reclaimed water reached the groundwater table, and that only enough moisture was available at the plants' root zone to meet their needs. To provide maximal soil take-up capacity for the spring melting, the available moisture at the plant roots should be depleted before the Autumn harvest, by reducing summer irrigation. U.S.A.

#### 95-1900

##### **The effect of sewage sludge treatment processes on oocysts of *Cryptosporidium parvum***

I. N. WHITMORE (WRc plc, Medmenham) and I. J. ROBERTSON

*Journal of Applied Bacteriology*, 1995, 78, No 1, 34-38

The influence of sewage treatment on *Cryptosporidium parvum* oocysts was studied in the laboratory. Oocysts were isolated by passing suspensions of sludge or soil through a 100 µm sieve followed by centrifugation of the filtrate and washing of the pellet. Viability was assessed by the method of Campbell. Sedimentation rates in raw sewage were 2.2-2.8 cm per h, considerably higher than values estimated for water, probably through coagulation and attachment to particles. Losses of viability in distilled water and anaerobic sludge at 35°C were similar, amounting to 90 per cent after 18 d. Aerobic digestion or pasteurization, both at 55°C, caused 92 per cent loss of viability in 5 minutes. The decline in sludge-treated soils was much slower, viability declining by 20-40 per cent at 20°C over 44 d. Temperature was the principal factor affecting oocyst survival. U.K.



## 95-1901

### Minimal UV dose requirements for the disinfection of biologically treated sewage.

K. U. RUDOLPH (Universität Witten/Herdecke), and C. OBERG  
*Korrespondenz Abwasser*, 1994, 41, No 12, 2254-2260 (in German, English summary)

Experiments were carried out with a mobile semi-industrial scale UV irradiation system at 2 sewage treatment plants, to determine the minimal UV dose necessary for compliance with EC limiting values and guide values for the bacteriological quality of bathing waters. In addition some bench scale tests were performed from which a direct measurement of the UV irradiation intensity could be combined with a variable duration of exposure to arrive at an estimate of the dose required for a given bacterial count reduction. A dose in the range 30 to 40 mJ per cm<sup>2</sup> was adequate to meet the EC bathing water requirements: the poorer transmissivity of the treated effluent at one of the 2 plants necessitating a 20 per cent higher energy input than at the other. The laboratory experiments also confirmed these results: an intensity of 38 mJ per cm<sup>2</sup> being necessary in order to comply with the target values for faecal coliforms, total coliforms and faecal streptococci. Higher dosages did not give rise to any greater reductions in the relevant counts, but energy costs were greatly increased by a lowered transmission of UV irradiation due to colloidal constituents, filterable solids did not appear to affect the energy consumption. (English translation 210 pounds sterling, valid for 1995) Germany

## 95-1902

### Bright lights - big plant.

D. CRAIG (Central Contra Costa Sanitary District, Martinez, Calif.), D. GELLERMAN, and A. FARRELL.

*Water Environment & Technology*, 1994, 6, No 12, 21-22

A description is given of the conversion of the disinfectant stage of a Californian sewage works from chlorination to UV. The change over was prompted by impending environmental regulations (the National Pollutant Discharge Elimination System) and by the need to expand throughput capacity within the existing works area. Daily flows ranged between 15-90 mgd, but provision had been made to accommodate 135 mgd. The system would use 7500 lamps. To achieve the required faecal coliform standard in the effluent, the depth of post-secondary treated water flowing over them was limited to 2.5 in: this requirement entailed widening the channel through which it flowed. A lamp cleaning schedule was established, each of 18 banks of lamps being cleaned every 2 weeks. A dedicated electricity sub-station was to be built to provide the power required, estimated at 650 kW. U.S.A.

## 95-1903

### Characterization of sludge from facultative aerobic lagoons.

M. A. DESJARDINS (École Polytechnique de Montréal, P.Q.) and F. G. BRIERE.

*Sciences et Techniques de l'Eau*, 1994, 27, No 4, 45-56 (in French, English summary)

The sludges obtained from 6 different lagoon systems for treatment of domestic sewage were assessed with respect to their dewatering properties, heavy metal contents and nutrient concentrations, with the possibility of their future utilization for agricultural purposes in mind. Nitrogen contents in general were adequate for use as fertilizers, although the suitability of alum coagulated sludges for this purpose was not verified. Some sludges exhibited high copper contents, exceeding the recommended maximum for agricultural use. Thickening and dewatering properties varied widely, with the bio-

logical sludges generally exhibiting superior settling performances relative to chemically-produced sludges. Only freeze-thaw conditioning (which tends to occur naturally in outdoor sludge drying beds) was capable of modifying the gelatinous consistency of the sludges obtained by coagulation using alum. In general a higher solids content could be achieved by the use of drying beds than by alternative mechanical dewatering methods. (English translation 450 pounds sterling, valid for 1995) Canada

## 95-1904\*

### ATAD - the effective treatment technology for pathogen reduction in municipal sludge.

H. G. SCHWINNING (Fuchs Gas und Wassertechnik GmbH, H. Mayen, Germany), L. FUCHS, K. DEENY, and H. REGNERSGAARD.

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. The Autoheated Thermophilic Aerobic Digestion (ATAD) process is a method developed and widely employed in Europe for the thermal disinfection of sewage sludge. It operates with a 6 d hydraulic residence time and the thermophilic reaction mechanisms in the temperature range 50-60°C ensure a high degree of stabilization and pathogen reduction in the digested sludge. The completely mixed aerobic reactors are fully enclosed and insulated, so that the process employs the heat liberated by biological decomposition for maintaining the reaction temperature at the required level. A broad description of the principles and performance capabilities of the method is presented based on operating experience in European countries and also in Canada, although 46 plants have been installed. International

## 95-1905

### Determination of ferric chloride dose to control struvite precipitation in anaerobic sludge digesters

D. MAMATIS (San Francisco City & Country, Calif.), P. A. PITT, Y. W. CHENG, T. LOIACONO, and D. JENKINS.

*Water Environment Research*, 1994, 66, No 7, 912-918

Anaerobic digestion of sludge favours the formation of struvite (magnesium ammonium phosphate) scales because ammonia, phosphate and magnesium are solubilized by the digestion process. A method for predicting the optimal ferric chloride dose for preventing struvite formation during anaerobic digestion was developed, based on the use of 2 bench scale continuous flow anaerobic digesters: a control digester and a digester receiving various doses of ferric chloride. The optimal ferric chloride dose for preventing struvite formation was defined as the amount to achieve a struvite concentration product of less than its solubility products. The amount of soluble phosphate and soluble magnesium available for precipitation and the ratio of soluble phosphate removed to iron added were determined. The amount of magnesium and phosphate solubilized in anaerobic digestion and available for precipitation was estimated to be approximately 68 per cent of the feed total magnesium and total phosphorus. The average ratio of soluble phosphate removed to iron added was 0.37. U.S.A.

95-1906

**Secondary formation of PCDD/F during the thermal stabilization of sewage sludge.**

W. BALZER (Chemisches Untersuchungsamt der Stadt Nürnberg), and P. PLUSCHKE.

*Chemosphere*, 1994, 29, No.9/11, 1889-1902.

The effects of sludge conditioned by the Porteous Process\* at 180-200°C and 28 bar on the concentrations of polychlorodibenzo-*p*-dioxins and dibenzofurans (PCDD/F) and other substances were studied through mass balances on samples before and after conditioning. Most compounds were enriched relative to sludge solids as organic matter was destroyed. Mean enrichment factors for heavy metals and PCB were close to 1.3 for PCDD/F; they reached 8 for PCDD/F, with tetra- and pentachlorinated dioxins showing the highest values. PCDD/F were clearly being produced by the process, probably from precursors such as chlorophenols. The resulting sludge had contributed a significant amount of these compounds to the environment. **Germany**

95-1907

**Surplus sludge thickening: capital charges and annual costs as a function of plant capacity.**

C. F. SEYFRIED (Universität Hannover), and F. OBENAU.

*Abwassertechnik*, 1994, 45, No.6, 31-40 (in German).

The problems connected with the thickening of waste activated sludges are discussed, and the economics of the sludge thickening process assessed with reference to several alternative treatments, namely gravity thickening, flotation, and various mechanical dewatering processes with or without the addition of flocculating agents. The capabilities of various treatments are considered with reference to the degree of concentration of the solids phase, and the final solids contents achieved. The costs of raising the solids content to an acceptable level (approximately 5 per cent) are analysed, taking into consideration the power requirements and the need for additives, together with the capital charges associated with the cost of the equipment. For many sludges, gravity thickening alone was considered the cheapest and most satisfactory method, but for sludges of very poor settling properties, the use of flotation presented the least expensive option for achieving a moderate degree of concentration. Higher solids contents could be achieved by other methods, but at greatly increased cost. (English translation 240 pounds sterling, valid for 1995). **Germany**

95-1908

**Studies of the fertilizing effect of dried sewage sludges.**

T. LANGENOHL, H. WITTE, U. HERKENRATH, and C. EBNET.

*Abwassertechnik*, 1994, 45, No.6, 42-44 (in German).

The trend in favour of the erection of sludge drying plants prompted an investigation of the effect of the drying process (including disc, rotary and centrifugal drying methods) on the fertilizing properties of the resulting dried sludge. The chemical composition of dewatered and dehydrated sludges prepared by the different methods were compared; contrary to previously published reports there did not appear to be any appreciable reduction in the content of the ammonium-nitrogen in the sludge solids, on a dry weight basis. The dried sludges however differed in their moisture contents, those produced by rotary and centrifugal drying methods having solids contents of 94.4 per cent while sludge dried in a disc dryer exhibited a solids content of only 63.2 per cent. The extractability of the phosphate fraction was also compared using either acidic (formic acid) or alkaline solutions as extractants, and indicated a pronounced reduc-

tion in the degree of phosphorus solubility as a result of drying in all 3 sludge types. However pot trials using meadow grass to determine the fertilizing effect of the sludges showed that, after 3 harvests of the vegetation, all 3 dried sludges performed better than inorganic fertilizer, their effect being barely distinguishable from that of the corresponding dewatered sludges. (English translation 105 pounds sterling, valid for 1995). **Germany**

95-1909

**Experiences of digested sludge thickening by Aercon.**

M. LYNCH (Cranfield University), and T. STEPHENSON.

*Journal of Institution of Water and Environmental Management*, 1994, 8, No.6, 585-590.

The Aercon process is a batch process for the pre-aeration of digested sludge to help speed up thickening and consolidation. The development and operation of a pilot-scale digested-sludge aeration and consolidation unit at the Penybont sewage treatment works by Welsh Water is described. The mechanisms, particularly metabolic inhibition, by which aeration speeded up consolidation were examined and possible methods of improving process performance were investigated. The effects of aeration intensity and cooling were studied. The consolidation of digested sludge was enhanced by aeration and by cooling the sludge prior to aeration. Inhibition of digestion was more important than gas stripping for post-digestion gravity consolidation. **U.K.**

95-1910\*

**Management of solids from biological nutrient reduction processes treatment plants - general observations and experience in the Sydney region.**

A. KANAK (Water Board, Burwood, N.S.W.).

*Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W.

Some of the problems associated with the dewatering and subsequent disposal of sludges resulting from biological nutrient removal processes are discussed against a background of the gradually expanding impact of these processes in the Sydney region. Compared with ordinary sewage sludge, BNR sludges were more odorous, more difficult to dewater to a level suitable for handling and transport, and more liable to infestation by flies and possibly rodents. The use of extended lagooning to counteract these tendencies was to be balanced against the risk of nutrient release into the supernatant, and careful control of both the runoff and the solids phases is essential. The beneficial uses of sludge dewatered to around 20 per cent comprised various forms of land application in the market sectors of horticulture, agriculture, silviculture and land rehabilitation, and current practice in each of these areas is reviewed, followed by a brief account of the use of lime stabilization, by the addition of quicklime. The resulting product has a high solids content (45 per cent), is relatively odour-free and useful in the amelioration of acid soils.

**Australia**

95-1911

**Hot from the press.***Water & Environment International*, 1994, 3, No.31, 20.

Restrictive legislation covering the disposal of municipal and industrial sludges made volume reduction important and required better soil mechanical properties for long-term landfill stability. Thermal dewatering was much more expensive than mechanical dewatering and needed more space. The Centridry system was a new development which incorporated an integrated drying zone using thermal drying into established mechanical sludge dewatering technology.

## SEWAGE

Both mechanical and thermal treatment stages were carried out in one unit. Sludge granules were dried to a consistency of 50-70 per cent dry solids. There was no odour nuisance because of low sludge temperatures, short drying times and low exhaust air temperatures. The process could be retrofitted to existing Centripress installations. Where incineration or other thermal schemes were planned for the future, it could be integrated with the new plant. **Germany**

### 95-1912

#### **Functioning and performance of all-purpose septic tanks.**

H. PHILIP (EPARC O, Metz), A. RAMBAUD and S. MAUNOIR

*Techniques Sciences Methodes* 1994 89, No 11: 645-650 (in French. English summary)

A general description of the nature and operation of septic tanks for the treatment of combined domestic wastewaters is presented against a background of French official regulations governing their design and construction and the effects of various loading rates and site conditions on their efficiency. Recommendations concerning the geometrical layout, frequency of sludge removal and general attention to ensure the maintenance of adequate biological activity and stabilization of the sludge are presented. Providing the tank was of sufficient dimensions, an average rate of sludge accumulation of 0.3 litres per person/d was reached after operation for about 2 years, and tended to decrease thereafter. As a result a septic tank with a capacity of 3 m<sup>3</sup> (suitable for up to 4 people) should not require emptying in less than 5 years. By increasing the size of the tank or by the addition of activators to stimulate the digestion of the sludge, it was possible to prolong the intervals between desludging even further. There are 34 references. (English translation 260 pounds sterling, valid for 1995). **France**

### 95-1913

#### **Small flow treatment uses algae**

W. A. SACK (West Virginia University, Morgantown), J. A. MCCUNN and R. M. TOMICH

*Water Environment & Technology* 1994 6, No 12: 22-23

A laboratory scale investigation of a novel treatment method for septic tank effluent is described. Effluent was passed through a gravel filter bed, from which it flowed through 4 sequential tanks, to the top of which were fixed screens of small interstice plastic, on which algae were cultivated, under light conditions which could be varied. The total residence time in the 5 units was approximately 6 d. Organic nutrients and heavy metals were initially added to provide base line data against which the extent of their removal could be assessed. The algal mat that formed on the tanks was scraped off once or twice weekly, removing most of the nutrients and trace metals accumulated. BOD removal and nitrification took place in the tanks, and photosynthetic activity both removed carbon dioxide and added oxygen. As carbon dioxide was removed, the pH rose, facilitating the reduction of phosphorus and trace metals by precipitation and of ammonia by volatilization. Depending on the length of time the algae received artificial light, 15-20 per cent of the septic tank effluent nitrogen was either converted into algal cell material or was volatilized as ammonia, while trace metals were reduced by 50-90 per cent, approximately half of this occurring in the gravel filter. **U.S.A.**

### 95-1914

#### **Importance and evaluation of old and new thermal treatment for sewage sludge disposal.**

R. BERGHOFF (Landesumweltamt NRW, Essen)

*Abwassertechnik* 1994 45, No 6: 46-48 (in German)

The possible thermal processes for beneficial utilization of sewage sludge are discussed, based on the application of extremes of temperature in the complete or partial absence of oxygen to produce gaseous or oil-like products which can be utilized either as fuel or for further organic synthesis. Although around 10 per cent of the total sludge arising in Germany was incinerated, the problems of atmospheric pollution and capital investment encouraged a search for novel processes with better environmental and economic prospects. The process of gasification is discussed, with reference to the chemical reactions taking place under controlled conditions of temperature and pressure, and the various commercial processes on offer, which are compared. The benefits of gasification processes are considered, involving compact plant design, production of fused vitreous slag as the only solids residue, and the energetic potential of the resulting product gases, which can be used for electricity generation or steam raising. Particular details of the Noell BDI process are referred to, in which gasification occurs in a jet stream at temperatures of 1400-1700°C; a similar process (Laubag method) has been in operation for the gasification of soft coal for some time and experiments were being conducted on the admixture of various wastes (including sludge) to the feed stream. (English translation 120 pounds sterling, valid for 1995). **Germany**

### 95-1915

#### **Current position regarding sewage sludge disposal - stipulations, methods and change**

H. DRIESCHNER

*Abwassertechnik* 1994 45, No 6: 50-51 (in German)

The present state of affairs in respect of sewage sludge disposal by different methods in Germany is reviewed, covering agricultural utilization, composting, dredged site reclamation, landfill, barrier layers, thermal treatment and landfill disposal. Each of these methods is considered, the problems and limitations arising as a consequence of regulatory controls and other factors being considered. The use of barrier membranes (in conjunction with fillers such as silicate or fly ash) is of limited validity, only sludges of over 30 per cent solids being acceptable, each application requiring separate agreement. Several trials of the incineration of sewage sludge in power stations and other waste disposal facilities were in progress, and the results of these are awaited as a basis for the wider application of this method. (English translation 90 pounds sterling, valid for 1995).

**Germany**

### 95-1916

#### **PCDD/Fs and non-o-PCBs in digested U.K. sewage sludges.**

A. SEWART (Lancaster University), S. J. HARRAD, M. S.

MCILACHLAN, S. P. McGRATH and K. C. JONES

*Chemosphere* 1995 30, No 1: 51-67

Sewage sludges collected from 12 rural and urban sewage works and archived samples from a long-term agricultural experiment were extracted and subjected to a preliminary separation by liquid-solid chromatography. Analyses were completed by gas chromatography/mass spectrometry, in some cases at high resolution. The latter allowed lower chlorinated congeners and toxicity equivalents (TEQ) to be determined. Total TEQ values were 19-206 ng per kg; the urban samples were highest, suggesting a major input from pentachlorophenol usage. The archived sludges, covering the period 1942-

1960 indicated changing sources of polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/F) over time and a decline in total TEQ since 1950. It was possible that routine sludge applications could raise soil TEQ above the 5 ng per kg limit in a few years. There are 32 references. U.K.

95-1917\*

**Beneficial use of nutrients in sewage sludge.**

F. J. CORBIN (NSW Agriculture, Richmond), I. BAMFORTH, J. COOPER and G. J. OSBORNE

*Second Australian Conference on Biological Nutrient Removal from Wastewater*. Proceedings BNR2 Conference, Albury, N.S.W.

Some experience of the beneficial effects of sludge applications on cultivated soils in the New South Wales area is reviewed with indications of the extent of nitrogen and phosphorus contents of the soil following the application of sludge and evidence of yield increases compared with the use of inorganic fertilizers. Increases in the yield of wheat of around 15 per cent were observed following sludge applications at rates of 3.8 to 14.8 tonnes per ha (dry weight). Usually nutrient analyses of sludge gave values of 2-4 per cent both for total nitrogen and total phosphorus on a dry weight basis. Trials on different soil types tended to give variable results, the most marked increases in soil nutrient contents following sludge application being obtained from a brown sodic soil of fairly high sand content, although the extraction procedure (Bray method) possibly tended to overestimate the percentage of bioavailable phosphorus. More definitive answers were required to questions such as the effect of soil type, climate, fertilizer application rate and crop uptake on the beneficial yield increments following sludge application.

Australia

95-1918

**Cocomposting in Los Angeles optimizes resource management**  
R. TABRIKANT (Bureau of Sanitation, Los Angeles, Calif.) and R. KEARNEY

*BioCycle*, 1994, 35, No 12, 58-60

Due to the U.S. EPA's ban on municipal biosolids dumping in the ocean, Los Angeles was now achieving 100 per cent beneficial use of such solids. Currently, about 900 wet tons of 24 per cent solids material per d are being managed through land application to farms in Arizona and southern California, cocomposting in central California and on-site energy recovery. Initially, various agricultural products were used as bulking agents for Los Angeles biosolids, but more recently, cocomposting with grass cuttings is taking place in a programme known as Full Cycle Recycle. U.S.A.

95-1919

**Characterization of the humic material formed by composting of domestic and industrial biowastes. part 1. HPLC of the cupric oxide oxidation products from humic acids.**

V. MIKKI (VTT Energy, Biofuels, Jyväskylä), K. HANNINEN, J. KNUUTINEN, J. HYÖTYLAINEN and R. ALFÉN

*Chemosphere*, 1994, 29, No 12, 2609-2618

Samples of sewage sludge, source separated domestic and horticultural biowaste and activated sludge from a kraft pulp mill were composted. Fresh and humified compost samples were tested. The humin content decreased after humification for all materials, but was at least 4 times that of a soil control. Humic acids increased in the sewage sludge and source separated biowaste composts during humification, but decreased in the pulp mill biosludge. The humic acids were degraded by cupric oxide oxidation and the products were analysed. The yield of identifiable aromatic degradation products

was between 0.9 and 2.0 per cent for all samples. Mostly similar products were found in all samples, but traces of 6-chlorovanillin in the kraft pulp composts might be a marker for organically bound chlorine. There are 35 references. Finland

## INDUSTRIAL EFFLUENTS

See also Abstracts 95-1690, 95-1700

95-1920

**Dynamic modelling of the effect of pH on the nitrification of high-strength effluents.**

A. PIRSING (Technische Universität Berlin) and U. WIESMANN

*Acta Hydrochimica et Hydrobiologica*, 1994, 22, No 6, 270-279 (in German, English summary)

A kinetic model of the process of nitrification in a completely mixed system is proposed, which in addition to the concentrations of nitrogen and biomass also included the proton concentration as an operating variable. The basis of the model is a series of mass balances involving 8 specific components, namely ammonia, nitrite, nitrate, dissolved oxygen, carbon dioxide, hydrogen ions, *Nitrosomonas* and *Nitrobacter*. The resulting equations take into consideration the effects of oxygen limitation and substrate inhibition. Various reactor systems were used as a means of calibration and verification of the model, including stirred tank reactor and fluidized bed reactor configurations. These were tested against the model under conditions of widely varying input concentrations. The level of agreement between the calculated and observed measurements was satisfactory for both types of reactor, nitrate production proved to be the rate limiting step at high reaction velocities as this condition was associated with a limitation of the oxygen supply, which influenced the growth of the *Nitrobacter* more than the *Nitrosomonas*. (English translation, 350 pounds sterling, valid for 1995). Germany

95-1921

**A comparative study of the physical characteristics of anaerobic granular sludges.**

J. QUARMBY (Birmingham University) and C. L. FORSTNER  
*Process Safety and Environmental Protection*, 1994, 72, No B4, 241-246

Data are presented on a range of sludges from upflow sludge blanket reactors in the U.K. and the Netherlands that were treating a wide range of wastewater sources including food, papermill, distillery and coffee wastes. A feature of the results of the physical and chemical characteristics of these sludges was that there was a wide granule strength range and that in a given reactor, sludge granules sampled from the bottom were not as strong as those obtained from higher levels. In general, a model suggests that granule strength is a function of the wastewater, a carbonaceous substrate that will result in the formation of a carbohydrate rich extracellular polymer and any metal ions (or inorganics) present in the feedstock. U.K.

95-1922

**Programme promotes waste minimization.**

B. A. PETRICK (Montgomery Watson, Denver, Colo.) and L. R. CHRISTENSEN

*Water Environment & Technology*, 1994, 6, No 12, 44-49

A comprehensive plan promoted and implemented in Lincoln, Nebraska to deal with liquid wastes of all types other than municipal sewage

## INDUSTRIAL EFFLUENTS

is outlined. Following discussions with generators and hauliers of wastes (principally industrial, but including some commercial, from sources such as restaurants and car washes) a system of permits and charges was evolved. A special treatment facility was built on the site of an existing sewage works, where certain processes and facilities, such as a laboratory, could be shared. The new works were sized according to data by the generators and hauliers on the total annual volume, the likely daily load per tanker, and quality. Each tanker's load was briefly examined at the laboratory to ensure that its quality conformed to that specified on a delivery note, and the contents then discharged to a hopper allocated to that type of waste, before treatment. Limits were set for acceptability: nothing below pH 4.5 or above pH 9.5 was taken, though arrangements were available on-site for bringing wastes to within those limits. Brief details of the operation of the scheme, and of the works, which came on stream in 1992, are given. Difficulties had been experienced with mechanical wear and tear on the blades of mixer impellers, from the grit and sand contained in some wastes, as compensation, some greasy wastes had proved to be an excellent source for methane production in the anaerobic digesters. U.S.A.

### 95-1923

#### **Industrial wastewater treatment today and tomorrow**

H. B. POLS (Institute for Inland Water Management and Waste Water Treatment, Tielstadt) and G. H. HARMSEN

*Water Science & Technology*, 1994, 30, No 3, 109-117

Industrial wastewater treatment processes are reviewed with respect to efficiency, energy, and environmental impact. Physical wastewater treatment processes included coagulation/flocculation, precipitation, sedimentation, ion flotation, filtration, microfiltration, ultrafiltration, centrifugation, and magnetic separation. Accumulation techniques included ion exchange, biosorption, adsorption, stripping, solvent extraction, perturbation, and pervaporation. Concentration techniques included reverse osmosis, evaporation, crystallization, freeze concentration, and eutectic freezing. Chemical treatment techniques included aerobic biological treatment, anaerobic biological treatment, chemical oxidation, wet air oxidation, supercritical oxidation, photocatalytic oxidation, and electrolytic detoxification. A multi-criteria analysis was developed for the determination of a priority sequence for these wastewater treatments. Netherlands

### 95-1924

#### **Distillative treatment of liquid industrial wastes**

K. LEONHARD (Munich Technical University, Garching), P.

FISNER, W. HAASE, and P. A. WILDFER

*Water Science & Technology*, 1994, 30, No 3, 139-147

The treatment of industrial wastes using stripping, evaporation, and rectification is considered. The principles and applications of each technique are outlined. Stripping effectively removes highly volatile substances and can reduce ammonia totally. Evaporation separates non-volatile and less-volatile materials from water in one process step and is the fundamental process step in multi-stage cleaning regimes. The rectification method can be used for further treatment of distillates or for the treatment of hazardous wastes, e.g. for the recovery of hydrochloric acid from acid wash waters from combustion plants for hazardous wastes. Germany

### 95-1925

#### **Persistence of inoculated hepatitis A virus in mixed human and animal wastes**

M. Y. DENG (Wisconsin University, Madison), and D. O. CLIVER

*Applied and Environmental Microbiology*, 1995, 61, No 1, 87-91

The persistence and apparent microbial inactivation of hepatitis A virus (HAV) in human wastes mixed with swine manure slurry and with dairy cattle manure slurry was studied. Septic tank effluent containing HAV was mixed with both the animal waste slurries. HAV was consistently inactivated more rapidly in the 2 types of mixed wastes than in septic tank effluent alone or in a control culture. A comparison of HAV inactivation in mixed wastes subjected to different treatments at the same pH and temperature indicated that HAV inactivation in the mixed wastes was related at least in part to microbial activity. The results were relevant to the spreading of mixed wastes on agricultural soils. U.S.A.

### 95-1926

#### **Biological nitrogen and phosphorus removal in an anaerobic/anoxic sequencing batch reactor with separated biofilm nitrification**

G. BORTONE (ENEA Bologna), F. MALASPINA, L. STANTE, and A. TILCHE

*Water Science & Technology*, 1994, 30, No 6, 303-313

Nutrient removal in an anaerobic/anoxic sequencing batch reactor with separated batch biofilm nitrification was studied and compared with that achieved in a 5-step anaerobic/anoxic/oxic sequencing batch reactor. Piggery wastewater was used as feed. The anaerobic/anoxic reactor showed very good nitrogen and phosphorus removal capacities and excellent sludge settling characteristics. However, organic carbon removal efficiency was lower with nitrate than with oxygen. Batch biofilm nitrification achieved very high nitrification rates. At 98 and more than 90 per cent, respectively, nitrogen and phosphorus removal were higher than in the anaerobic/anoxic/oxic reactor. Italy

### 95-1927

#### **COD reduction kinetics in a biological batch reactor: effect of impeller submergence and speed**

D. DEEPAK (Roorkee University), R. K. GUPTA, and S. D. BHATTACHARYA

*Chemical Engineering Journal*, 1994, 56, No 1, B43-B48

Data are presented on organic matter utilization in an agitated 450 by 450 by 1070 mm reactor using a mixed culture of sewage origin. Using impeller submergence depths of 0-200 mm and impeller speeds of 40-120 rpm, the COD reduction rate increased consistently as the impeller speed increased up to 100 rpm. Moreover, as the impeller depth increased, the COD reduction rate decreased, with the maximal COD reduction occurring at the surface (i.e. at zero impeller submergence) due to the large exposure of the water molecules to the air. India

### 95-1928

#### **The use of white rot fungus *Funalia troglia* (Malaysia) for the decolorization and phenol removal from olive mill wastewater**

O. YESILADA (Inonu University, Malatya), K. FISKIN, and E. YESILADA

*Environmental Technology*, 1995, 16, No 1, 95-100

Cultures of white rot fungus were grown in diluted olive mill wastewater (OMW). The organisms were assayed by the method of Sayadi and Ellouz. The growth curves of static and agitated cultures

were similar; the cultures removed 31 and 38 per cent of OMW, colour respectively, COD was removed by 40 and phenol by 72-77 per cent. Phenol reduction, which was parallel to colour removal, ceased after 8 d incubation, suggesting that most of the colour was phenolic in origin. **Turkey**

#### 95-1929\*

##### **Effect of pretreatment on the nutrient removal efficiency in high strength wastewater using SBR technology.**

K. SUBRAMANIAM (Queensland University Brisbane), J. KELLER, K. M. HO, M. R. JOHNS, and P. F. GREENFIELD. *Second Australian Conference on Biological Nutrient Removal from Wastewater*, Proceedings BNR2 Conference, Albury, N.S.W. High-strength wastewaters from a large abattoir near Brisbane were routinely discharged to a 5 stage pond treatment system with 2 anaerobic ponds at the front end to achieve a considerable reduction in organic loading. Of these 2 ponds the first achieved less COD removal than the second, acting largely as a pre-acidification stage. Three identical bench-scale sequencing batch reactors (SBR) were set up to test the possibility of using this method for treating the effluent from either anaerobic pond 1, pond 2 or a mixture of the two and particularly the use of the SBR technique for biological nutrient removal. Almost complete nutrient removal was obtained in the case of effluent from pond 1, the concentration of oxidized nitrogen being reduced to 10-20 mg per litre, with less than 0.5 phosphate-phosphorus mg per litre and a residual COD of 100-200 mg per litre. These levels could be maintained over a period of 2 months. For the effluent from pond 2 however only partial nitrification was achieved with little overall reduction of nitrogen and phosphorus. With a mixture of equal parts of both effluents, a good nutrient removal performance was achieved for part of the time. The significance of these results for further design of SBR systems for nutrient removal was being investigated further. **Australia**

#### 95-1930

##### **Pilot-scale, high-strength industrial wastewater treatment evaluation by mathematical modelling.**

F. DOBOLYI (Treatwater International Ltd, Warrenpoint), and I. TAKACS

*Water Science & Technology*, 1994, 30, No 3, 119-128

Pilot scale experiments were conducted to select the best available technology for treating slaughterhouse wastewater from the Ulster Farm By Products Ltd rendering plant to comply with stricter legislation. The wastewater was characterized by high BOD total Kjeldahl nitrogen contents. Single sludge nitrification-denitrification technology was selected for the full scale treatment plant. A mathematical model of the plant was developed to verify the applicability of the general activated sludge model under high concentration influent conditions and to predict plant performance. **U.K.**

#### 95-1931

##### **Efficient biological nutrient removal in high strength wastewater using combined anaerobic-sequencing batch reactor treatment.**

K. SUBRAMANIAM (Queensland University Brisbane), P. F. GREENFIELD, K. M. HO, M. R. JOHNS, and J. KELLER. *Water Science & Technology*, 1994, 30, No 6, 315-321

The effectiveness of a sequencing batch reactor process, in combination with differing anaerobic pretreatment processes, in the removal of carbon, nitrogen and phosphorus from abattoir wastewater was examined. In this combination of processes, the degree of anaerobic treatment had to be controlled to maintain sufficient COD

for biological nitrogen and phosphorus elimination. A reactor treating effluent from the first stage of an anaerobic wastewater treatment pond achieved overall removals of COD, total Kjeldahl nitrogen, total phosphorus and suspended solids greater than 95, 92, 90 and 94 per cent, respectively. A non bulking sludge with a sludge volume index of less than 100 mg per g was obtained. **Australia**

#### 95-1932

##### **Anaerobic treatment of distillery slops in the circumstances of Central Europe.**

P. JENICEK (Prague Institute of Chemical Technology), J. ZABRANSKA, and M. DOHANYOS

*Water Science & Technology*, 1994, 30, No 3, 157-160

The anaerobic treatment of molasses distillery slops in Central Europe, where sugar beet molasses are used as the raw materials and the largest production of ethanol is produced by fermentation, is considered. Treatment of the slops in a pilot scale upflow anaerobic sludge blanket (UASB) reactor, operated for 2 years, is described. The slops were diluted by other wastewaters from the distillery to a concentration of 25 g COD per litre and then treated in the reactor at 32°C at a volumetric loading rate of 7.1 kg per m<sup>3</sup> d. A COD removal rate of 78.8 per cent was achieved with a volumetric gas production of 2.6 m<sup>3</sup> per m<sup>3</sup> d. For the distilleries in the Czech Republic, this meant an annual energy potential of 12-17 million m<sup>3</sup> of gas fuel. **Czech Republic**

#### 95-1933

##### **Photodegradation of surfactants. XV: formation of sulphate ions in the photooxidation of sulphur-containing surfactants.**

H. HIDAKA (Meiji University Tokyo), K. NOHARA, K. OOSHII, J. ZHAO, N. SERPONE, and E. PELIZZETTI. *Chemosphere*, 1994, 29, No 12, 2619-2624

The photodecomposition of surfactants containing sulphonate, sulphate or thioether carboxylate groups was studied. Zinc oxide was a more efficient catalyst than titanium dioxide for the production of sulphate ions. No photoreductive decomposition to hydrogen sulphide was detected. Sulphonate and sulphate groups were probably converted to sulphate ions via sulphite ions. Sulphate ion production from compounds containing a benzene ring quickly reached equilibrium conditions. Derivatives with a sulphur group at an alpha carbon produced more sulphate ions than those with a sulphur group at a beta carbon. **Japan**

#### 95-1934

##### **Photocatalytic degradation of simulated pesticide rinsates in water and water plus soil matrices.**

J. R. CHIARENZELLI (SUNY Oswego NY), R. J. SCRUDATO, D. L. RAHERTY, M. L. WUNDERLICH, R. N. ROBERTS, J. J. PAGANO, and M. YATI. *Chemosphere*, 1995, 30, No 1, 173-185

Titanium dioxide powder was added to simulated wastewaters containing 5 commercially available pesticides and the suspension irradiated by UV light at 365-400 nm for 24 h, extracted, concentrated and analysed by gas chromatography. After 24 h, 79, 47, 25, 85 and 71 per cent of propyzamide, dicloran, triadimefon, chlorpyrifos and permethrin were recovered respectively. Similar results obtained in the presence of soil with the exception of triadimefon which was completely recovered. Losses were considered the result of mineralization rather than volatilization and partial decomposition. Any practical application would have to optimize the simultaneous exposure of contaminants to light and catalyst. **U.S.A.**

## INDUSTRIAL EFFLUENTS

95-1935

### Anaerobic digestion of starch particulates in an upflow sludge blanket filter reactor.

H. H. P. FANG (Hong Kong University), and I. S. KWONG  
*Environmental Technology* 1995, 16, No 1, 13-23

The effect of starch particulates on a laboratory anaerobic upflow sludge blanket filter reactor was evaluated at 37°C and pH 7.0-7.5 over 415 d during which the COD load rose from 3 to 50 kg per m<sup>3</sup> d. Starch became the sole substrate above a load of 10 kg COD per m<sup>3</sup> d. Only about 1.2 per cent of the starch remained unhydrolysed after treatment and about 5.9 per cent became soluble COD in the effluent for loadings up to 40 kg COD per m<sup>3</sup> d. The sludge yield was 0.10 kg volatile suspended solids per kg COD, 86.1 per cent of the COD was converted to methane. Starch did not accumulate in the reactor. The bulk of effluent solids consisted of biomass. The starch-degrading granules had a higher methanogenic activity than those arising from the metabolism of soluble carbohydrates. There are 33 references. Hong Kong

95-1936

### New fluoride recovery process based on crystallization of calcium fluoride.

I. A. GILSEN, and I. G. ONDILDELINDEN

*Water & Wastewater International* 1994, 9, No 6, 16-18

The Crystalactor process, developed by DHV Water BV, recovers fluoride from treated wastewater with excellent efficiency using controlled crystallization of calcium fluoride in a fluidized bed type crystallizer. Some of calcium chloride is added to the wastewater and the calcium fluoride is deposited as pellets in a rapid and controlled reaction. Typically, a Crystalactor unit can recover 5-18 kg fluorine per h m<sup>2</sup> of reactor cross section and can reduce the fluoride concentration to 2-5 ppm from 5-30 ppm. The process was suitable for many types of industrial wastewaters such as those produced in the steel, aluminium and dye manufacturing industries. Netherlands

95-1937

### Start-up strategy for SBR treatment of complex industrial wastewater.

M. MUNIZ (Oviedo University), A. G. LAVIN, and M. DIAZ  
*Water Science & Technology* 1994, 30, No 3, 149-155

A start-up strategy for sequential batch reactors (SBR) for the biological treatment of industrial wastewaters was developed using a pilot-scale column. The strategy was based on optimizing final efficiency in terms of COD and settling, cost of the start-up, sludge transport, and time. The strategy was divided into filling and conditioning periods with different restrictions for each period. The strategy was applied to the start-up of a SBR treating a complex organic high-salinity wastewater. Spain

95-1938

### Pollution prevention and wastewater treatment in pulp and paper industry.

H. M. POXIGI VARALDO (Centre of Advanced Studies and Research)

*Water & Wastewater International* 1994, 9, No 6, 12-15

Pollution prevention and control measures in the pulp and paper industry are reviewed in North America and Mexico. Contemporary industrial practice, environmental standards, criteria for discharges, are trends in processes and prevention in the pulp and paper industry are discussed. Ozone bleaching to replace the use of chlorine gas, hypochlorites and other bleaching agents had become practical. It

was possible to produce a wastewater that was virtually colourless and with an organic loading of 2 kg BOD per dry pulp tonne. Oxygen bleaching was also being successfully utilized to reduce the BOD and colour in the chemical pulp by 50 and 60, per cent respectively. In addition, hydrogen peroxide could also be used as a bleaching agent due to its world market price reduction. Mexico

95-1939

### Treatment of pulp and paper industry wastewaters in novel moving bed biofilm reactors.

B. RUSTEN (Aquateam - Norwegian Water Technology Centre Oslo), E. MATSSON, A. BROCH-DUE, and T. WESTRUM  
*Water Science & Technology* 1994, 30, No 3, 161-171

A new moving bed biofilm reactor (MBBR) was developed where the biofilm grows on small, free-floating plastic elements. Pilot tests were conducted with the MBBR at 4 pulp and paper mills in Norway and Sweden producing coated fine paper, bleached sulphate pulp, chemi-thermomechanical pulp and ground wood pulp, and neutral sulphite semi-chemical pulp. Effluent concentrations averaged below 10 g BOD<sub>7</sub> per m<sup>3</sup> using an aerobic MBBR plant with a total empty bed hydraulic retention time of 40 minutes followed by coagulation and solids separation. Full-scale reactors were constructed at 2 of the pulp mills. Scandinavia

95-1940

### Advanced treatment of paper mill effluents by a two-stage activated sludge process.

L. KNUDSEN (I. Kruger Systems AS, Soborg), J. A. PEDERSEN, and J. MUNCK

*Water Science & Technology* 1994, 30, No 3, 173-181

A 2 stage activated sludge process for the treatment of concentrated paper mill wastewater, characterized by a high load first stage and a low load polishing second stage, is described. Pilot scale tests were conducted during 1993 at a Danish paper mill producing pulp from recycled paper. Soluble COD and BOD effluent concentrations of less than 230 mg per litre and 10 mg per litre were obtained. COD, BOD<sub>5</sub> and organic nitrogen reductions of 85, 99 and 76 per cent were achieved. Almost all of the biodegradable organic substances were removed by the process. The pilot scale results were confirmed by full scale tests at another paper mill. Denmark

95-1941

### Activated carbon addition to activated sludge in the treatment of Kraft pulp bleaching wastes.

F. CECELN (Bogazici University, Istanbul)

*Water Science & Technology* 1994, 30, No 3, 183-192

The effect of adding powdered activated carbon (PAC) to activated sludge in the treatment of Kraft pulp bleaching effluents containing large amounts of nonbiodegradable matter was studied in continuous-flow and batch reactors. Isotherms were developed for PAC and biomass adsorption. The nonbiodegradable COD in the effluents amounted to 40-60 per cent of the initial COD. Substrate removal occurred principally by biodegradation and air stripping and biosorption effects were negligible. The nonbiodegradable part, particularly colour, was effectively removed using PAC addition. No bioregeneration was observed when activated sludge and PAC were combined. The combined PAC and activated sludge process appeared to be a combination of adsorption and biodegradation. Turkey

95-1942

**Production dependent specific data of paper mill wastewaters: information for treatment and reuse.**

( H. MOBIUS (CM Consult, Augsburg) and M. CORDES-TOLLE

*Water Science & Technology* 1994, 30, No 3, 193-198

The selection of suitable wastewater treatment processes in the paper industry depends on the type of wastewater characterized by specific data of paper mill wastewaters. A table of mean values of parameter ratios for different paper mill wastewaters is presented. Suitable treatment processes for different paper mill wastewaters are described. Treatment processes discussed are: activated sludge treatment, anaerobic treatment followed by activated sludge treatment, high capacity trickling filter followed by activated sludge treatment, aerobic submerged biofilters, and low capacity trickling filters. The feasibility of water reuse prior to or following biological wastewater treatment is considered. **Germany**

95-1943

**Advanced biological treatment of papermill wastewaters: effects of operation conditions on COD removal and production of soluble organic compounds in activated sludge systems**

( J. FRANTA (Munich Technical University, Garching), B. HELMRICH, M. PRIBYL, E. ADAMIETZ and P. A. WILDERER

*Water Science & Technology* 1994, 30, No 3, 199-207

Sequencing batch reactor (SBR) experiments with paper mill effluent and synthetic wastewater were conducted to examine factors affecting residual organic compounds in the effluent of biological wastewater treatment plants. The highest COD removal and best sludge settling properties for the paper mill wastewater were obtained with the greatest sludge age (20 d) and the longest reaction period (22 h). In the treated paper mill wastewater, 73 per cent of the residual organics had a molecular size range of 10 000-1000 Da. This fraction contained the coloured constituents. Approximately 10 per cent of the residual COD consisted of microbially altered organic compounds. Single substance analyses using GC-MS and pyrolysis GC-MS were required to detect the effects of operating parameters on the chemical composition of residual COD. **Germany**

95-1944

**Aerobic treatment of effluent from the wood panelling industry**

( X. Z. LI (Hong Kong Polytechnic), B. H. BOYDEN and D. SUN

*Water Science & Technology* 1994, 30, No 3, 217-223

Intermittent decanted aerated reactors (IDAR) were used for the biological treatment of eucalypt effluent from the thermo-mechanical wood panel industry. The construction and operation of the IDAR is described. Total COD and BOD<sub>5</sub> removals of 50-80 and 90-96 per cent, respectively, were achieved. BOD and COD removals were greatest using a sludge age of greater than 20 d and I/M ratios less than 0.2. Mixed liquor volatile suspended solids and solids retention time were dependent on the initial concentration of substrate and hydraulic retention time. A kinetic model showed an overall sludge yield of 0.45 (g biomass per g COD removed). Biological treatment in the IDAR increased effluent colour. **Hong Kong**

95-1945

**Decolorization of mono-azo dyes in wastewater by advanced oxidation process: a case study of acid red 1 and acid yellow 23**

( H. Y. SHU (New Jersey Institute of Technology, Newark), C. R. HUANG and M. C. CHANG

*Chemosphere* 1994, 29, No 12, 2597-2607

The photo-oxidation of 2 non biodegradable azo dyes was studied in a UV/hydrogen peroxide photochemical reactor. The decomposition of both dyes followed pseudo first order kinetics. Altering the hydrogen peroxide initial concentration showed that the reaction rate increased with increasing concentration but reached a maximum at about 9.5 mM. Increasing the pH decreased the reaction rate because under alkaline conditions the hydrogen peroxide decomposed into water and oxygen rather than hydroxyl radicals. Increasing initial acid red 1 concentrations decreased the reaction rate constants. Light intensity was positively correlated with the rate constant and also with the removal of total organic carbon from the reactor. **U.S.A.**

95-1946

**Dye removal from wastewater by adsorption on 'waste' Fe(III)/Cr(III) hydroxide**

( C. NAMASIVAYAM (Bharathiar University, Coimbatore, Tamil Nadu), R. JLYAKUMAR and R. J. YAMUNA

*Waste Management* 1994, 14, No 7, 643-648

Waste iron(III)/chromium(III) hydroxide is generated from the treatment of chromium(VI) containing wastewaters in the fertilizer industry, and has been used for the adsorption of Congo red (direct dye) from aqueous solutions. Various parameters that influence this adsorption process were examined, and these included the agitation time, the initial dye concentration, the pH and the adsorbent dosage. The waste was a powder that had a particle size ranging from less than 53 to 500 µm and above, and since it was a waste product, any treatment method based on it was expected to be economically viable. When the pH of a solution containing 50 mg of the dye per litre was increased from 3 to 12, the percentage removal was reduced from the maximal value of 91.3 to 24.9 per cent. An advantage of this waste was that neither the iron(III) nor the chromium(III) dissolved in the water being treated. **India**

95-1947

**Ozonation - an important technique to comply with new German laws for textile wastewater treatment**

( F. GAHR (Institut für Textilchemie der Deutschen Institute für Textil- und Faserforschung Stuttgart, Denkendorf), I.

HERMANUTZ and W. OPPIERMANN

*Water Science & Technology* 1994, 30, No 3, 255-263

German legislation affecting the treatment of textile wastewaters is outlined. Treatment techniques for textile wastewaters from pretreatment, dyeing, printing and finishing stages are listed. The most widely used process in Germany for wastewater treatment of dye plants was coagulation. The potential for ozonation to replace or supplement coagulation is considered. The ozonation of 10 reactive dyes (Red 2, Red 120, Red 35, Orange 82, Blue 29, Red 123, Red 12, Blue 4, Blue 38 and Red 23) was investigated. The specific ozone consumption for the decoloration of 1 g of reactive dye was 0.25-0.4 g ozone. This corresponded to a 95 per cent decoloration and was accompanied by a COD reduction of 5-20 per cent. **Germany**



## INDUSTRIAL EFFLUENTS

95-1948

### **On-line monitoring and control of the textile wastewater colour removal process**

C. N. CHANG (Tungshai University, Taichung City), R. F. YU, A. C. CHAO and S. TOJO

*Water Science & Technology* 1994, 30, No 3, 265-274

The finishing wastewater from textile plants is characterized by concentrated organic matter and high colour. Chemical oxidation is considered the most cost effective method of removing colour. An on-line colour measurement technique with feed back control of the oxidation process is described. Experiments showed that oxidation/reduction potential (ORP), solution pH, chemical dosage applied and resulting colour of the treated samples were linearly related. The ORP value could be used as a control parameter of the oxidation process. The results were modelled using a modified Nernst equation to relate oxidant dosage requirement to the working solution pH, initial colour, initial ORP and final ORP. The dosage requirement, colour removal efficiency and time required to complete the oxidation reaction could be calculated. **Taiwan**

95-1949

### **Removal of dyewaste colour from sewage effluent - the use of a full scale ozone plant**

J. H. C. HURCHLEY (Severn-Trent Water Ltd, Coventry)

*Water Science & Technology* 1994, 30, No 3, 275-284

Textile dyeing within the Severn-Trent region, U.K., produces highly coloured wastewater which has been traditionally discharged untreated into a foul sewer. The National Rivers Authority had set colour standards for certain sewage treatment works in the region. These were based on a river quality objective, expressed as absorbance of a filtered sample at 7 wavelengths. Colour removal methods include oxidation, reduction, adsorption, chemical flocculation and membrane filtration. Ozonation was introduced at the Leek sewage treatment plant for colour removal. The ozone plant has ensured compliance with the colour consent for 35 out of 39 samples but the 100 per cent compliance required by the consent had not quite been met. **U.K.**

95-1950

### **Recovery of chromium from tannery effluents using a redox-adsorption approach**

J. F. ODWYER (Limerick University) and B. K. HODNITT

*Journal of Chemical Technology & Biotechnology* 1995, 62, No 1, 30-37

A 4-stage redox-adsorption system was established for the separation and recovery of sodium and chromium(III) using Amberlite IR120 H cation exchange resin to remove the sodium in the waste stream in the second stage. The first stage involved the oxidation of the chromium(III) to the hexavalent form using oxidizing agents, and in the third stage, the anionic chromium(VI) form passed unaltered through the resin together with the waste stream, and in its dichromate form was reduced back to the trivalent cationic form which was then removed from the waste stream by a second Amberlite IR120 H ion exchange bed in the fourth stage. This method could be applied to any concentration level enabling it to be used as a primary, secondary or tertiary treatment process. **Ireland**

95-1951

### **Chromium removal and recovery from tannery wastes: laboratory investigation and field experience on a 10 m<sup>3</sup>/d demonstration plant.**

D. PETRUZZELLI (Istituto di Ricerca sulle Acque, Bari), G.

PIRAVANTI, M. SANTORI and R. PASSINO

*Water Science & Technology* 1994, 30, No 3, 225-233

A new ion exchange process, the IERECHROM process, for the removal, separation and recovery of chromium from tannery wastes is described. The process is based on the removal of metals from liquid effluent using a weak electrolyte carboxyl resin followed by selective separation and recovery during a regeneration step. A 10 m<sup>3</sup>/d pilot plant was designed and built to demonstrate process reliability. Approximately 90 per cent of the influent chromium was recovered as chromium hydroxide. Aluminium was partially recovered (37 per cent) as aluminate in the first regeneration step. The rest was precipitated as aluminium hydroxide. Ferric species were quantitatively recovered in the final polishing step. The economics of the process are outlined. **Italy**

95-1952

### **2-Mercaptobenzothiazole degradation in laboratory fed-batch systems**

H. De WEVER (Laboratory for Industrial Microbiology and

Biochemistry, Heverlee) and H. VIERA CHIERI

*Applied Microbiology and Biotechnology* 1994, 42, No 4, 623-630

2-Mercaptobenzothiazole (MBT) is used as a vulcanization accelerator in rubber manufacture, and is present in the sludge obtained from rubber chemicals wastewater treatment. MBT degradation was examined in laboratory activated sludge systems with the MBT being added as a 50 per cent aqueous solution. In addition, the sludges also contained benzothiazole (BT), 2-hydroxybenzothiazole (OBT) and benzothiazole-2-sulphonate (BTSO<sub>3</sub>). The degradation of MBT at 50 and 20 mg per litre is illustrated in the form of time versus concentration profiles, with the degradation trends at both concentrations being similar in terms of the time scale. Other time versus concentration profiles were determined for the effect of MBT on the other constituents (BT, OBT and BTSO<sub>3</sub>) in the sludges. **Belgium**

95-1953

### **Toxicity of 2-mercaptobenzothiazole towards bacterial growth and respiration**

H. de WEVER (Leuven Catholic University, Heverlee), K. de

MOKR and H. VLRACHTERT

*Applied Microbiology and Biotechnology* 1994, 42, No 4, 631-635

The effects of 2-mercaptobenzothiazole (MBT) on *Escherichia coli*, *Pseudomonas fluorescens*, *Sarcina lutea*, *Erwinia carotovora*, *Paracoccus denitrificans* and *Saccharomyces cerevisiae* growth and respiration were examined in both poor and rich nutrient media. The evidence suggested that 100 per cent growth inhibition was apparent at a 100 mg MBT per litre concentration, although in certain mineral media inhibition occurred at somewhat lower MBT concentrations. MBT also appeared to be active at the level of respiratory chains, although growth inhibition was apparently more pronounced than respiratory inhibition. **Belgium**

95-1954

**A hydrolysis/thickening/filtration process for the treatment of waste activated sludge.**

S. E. WOODARD (Woodard and Curran, Inc., Portland, Me.), and R. F. WUKASCH

*Water Science & Technology*, 1994, 30, No 3, 29-38

A process was developed for reducing the mass and volume of waste activated sludge generated by the biological treatment of a pharmaceutical wastewater. The waste minimization process involved room temperature sludge acid hydrolysis using sulphuric acid which resulted in 50-60 per cent solubilization of suspended solids, reducing the mass of solids. Carbon dioxide was liberated, enabling solids separation and thickening to occur via flotation. Supernatant hydrolysate could then be recycled to enhance solids solubilization. The residual solids were pressure filtered to cake dryness in excess of 50 per cent solids. Hydrolysis optimization studies, hydrolysate recycle studies and filtration studies are described. U.S.A.

95-1955

**Kinetics of the aqueous alkaline homogenous hydrolysis of high explosive 1,3,5,7-tetraaza-1,3,5,7-tetranitrocyclooctane (HMX).**

H. M. HELLMANN (California University, Los Angeles), M. K. STENSTROM, R. P. X. HESSELMANN, and U. WIESMANN

*Water Science & Technology*, 1994, 30, No 3, 53-61

The kinetics for the aqueous alkaline hydrolysis of the high explosive 1,3,5,7-tetraaza-1,3,5,7-tetranitrocyclooctane (HMX) and the temperature dependence of the rate constants were investigated in the development of a treatment scheme for wastewater contaminated with the explosive. The proposed treatment scheme consisted of adsorption on activated carbon, alkaline hydrolysis, and biological treatment. The alkaline hydrolysis of HMX was studied at 50-80°C. HMX was analysed by HPLC. Alkaline hydrolysis of HMX followed pseudo first-order kinetics. Second-order rate constants were calculated from the pseudo first-order equations. The temperature dependency of the rate constants was evaluated using the Arrhenius equation. An increase of 10°C led to an average 3.16 fold increase in the second-order rate constants. The alkaline hydrolysis was rapid at 60-80°C with base concentrations of 23 mmol hydroxide per litre. U.S.A.

95-1956

**Alkaline hydrolysis of munitions-grade nitrocellulose.**

J. F. ALLEMAN (Purdue University, West Lafayette, Ind.), B. I. KIM, D. M. QUIFFY, and L. O. EQUIHI A

*Water Science & Technology*, 1994, 30, No 3, 63-72

Cellulose nitrate is used in the manufacture of explosives. Particulate nitrocellulose residues have proved surprisingly stable when exposed to conventional waste degradation methods and are presently burned in open pits. The chemical degradation of nitrocellulose by alkaline hydrolysis was investigated using industrial-grade and munitions-grade nitrocellulose. The effects of caustic agent (potassium hydroxide, sodium hydroxide, calcium hydroxide), digestion temperature (25-50°C), and caustic doses (1-5-10 per cent) on alkaline hydrolysis were determined. Detailed analytical measurements were obtained during batch digestion of 0.6 per cent nitrocellulose with 1 and 4 per cent sodium hydroxide at 25°C. Low caustic dosages at ambient temperature could achieve sizeable digestion levels (82 per cent of available carbon released with 1 per cent sodium hydroxide). Cyanide at low ppm levels was formed during alkaline hydrolysis. Significant levels of nitrite and nitrate were formed. U.S.A.

95-1957

**Treatability of 2,4-D production wastewaters.**

O. TUNAY (Istanbul Technical University), S. FRIDEN, D. ORHON, and I. KABDASLI

*Water Science & Technology*, 1994, 30, No 3, 73-78

Wastewaters from 2,4-D production were characterized as acidic (pH 1) and containing 20,000-40,000 mg COD per litre and 17,000-30,000 mg chloride per litre. The chemical oxidation of the wastewater with hydrogen peroxide was optimized with respect to oxidant dose, pH, catalyst type and concentration, and time. The optimal conditions were 3.1 hydrogen peroxide COD oxidant dosage, 3000 mg iron(III) per litre as catalyst, and pH 3. Under these conditions, 96 per cent oxidation was achieved. A dosage of 0.5 l hydrogen peroxide COD led to 67 per cent oxidation. Turkey.

95-1958

**The determination of anaerobic biodegradability of pharmaceutical wastes by methanogenic activity tests.**

J. ZABRANSKA (Institute of Chemical Technology, Prague), P. JENICEK, and M. DOHANYOS

*Water Science & Technology*, 1994, 30, No 3, 103-107

Methanogenic activity tests were used for the determination of anaerobic biodegradability of 3 concentrated pharmaceutical wastes: excess biomass from threonine production, mycelium after penicillin extraction, and excess activated sludge from the treatment of other pharmaceutical wastewaters. The initial biomass loadings were 1.15-8.8 g COD per g volatile suspended solids. Retention times needed for 80 per cent degradation efficiency were evaluated and were used to assess the start up biomass loading rate. The optimal substrate concentration was evaluated as 12 g COD per litre. Specific methane yields were 0.28, 0.33, 0.19 and 0.30 litre methane per g COD for the threonine biomass, the mycelium, the activated sludge and the mixed waste, respectively. Czech Republic.

95-1959

**Decomposing organic chlorine compounds in dry cleaning wastewater by Fenton's reaction on reticulated iron.**

Y. TAKEMURA (Nippon Steel Corp., Tokyo), K. SENO O, I. MUKAI, and M. SUZUKI

*Water Science & Technology*, 1994, 30, No 3, 129-137

A method for degrading tetrachloroethylene and 1,1,1-trichloroethane in dry cleaning wastewater was developed using Fenton's reaction with iron. Reticulated iron was the most effective source of iron tested. In model solutions of tetrachloroethylene in pure water, the tetrachloroethylene was easily degraded to less than 0.1 mg per litre within 3 h. In dry cleaning wastewaters the concentration of tetrachloroethylene did not fall below 1.5 mg per litre even after 24 h, due to the interference from other organic compounds. A combination of circulation and air bubble agitation led to the removal of 99.8 per cent of tetrachloroethylene. Japan.

95-1960

**Adsorption of trivalent chromium ions from aqueous solutions onto activated carbon.**

R. LEYVA RAMOS (Centro de Investigacion y Estudios de Posgrado, San Luis Potosi), I. FUENTES RUBIO, R. M.

GUERRERO CORONADO, and J. MENDOZA-BARRON

*Journal of Chemical Technology & Biotechnology*, 1995, 62, No 1, 64-67

In experimental work using CACR-type activated carbon in a batch adsorber, pH played a very important role in the adsorption of trivalent chromium ions. Thus, in studies on the effect of pH values

## INDUSTRIAL EFFLUENTS

of 2, 4, 5 and 6, there was no adsorption below 2 and at pH values above 6.4 and the chromium(III) was precipitated as the hydroxide. Maximal adsorption was noted at pH 5. The adsorption capacity of the activated carbon was increased by about 20 per cent as the temperature was raised from 25 to 40°C. The technique showed promise as an alternative method for removing chromium(III) from aqueous solutions. **Mexico**

### 95-1961

#### **Treatment of metal industrial wastewater by fly ash and cement fixation.**

C. H. WENG (Delaware University, Newark) and C. P. HUANG  
*Journal of Environmental Engineering* 1994, 120, No 6, 1470-1487

A method for the treatment of industrial wastewater containing heavy metals using fly ash adsorption and cement fixation of the metal laden adsorbent was investigated. The major alkalinity contributors of fly ash were calcium oxide, potassium oxide and magnesium oxide. The percentage removal of zinc and cadmium from the wastewater increased with fly ash concentration. Seventy and 100 per cent zinc removal was observed at 50 and 100 g fly ash per litre dosage, respectively. The experimental data could be analysed by the Langmuir adsorption isotherm. The cadmium and zinc adsorption capabilities were 0.27 mg per g and 0.05 mg per g, respectively. A mortar specimen prepared with 10 per cent metal laden fly ash showed a 56 d strength similar to that of cement alone. Compressive strength tests showed that the optimal water to binding ratio was approximately 0.45. The compressive strength of the mortar decreased with increasing fly ash or metal laden fly ash content. Leachates contained less than 0.1 ppm of cadmium, copper, lead, zinc, nickel and silver. There are 47 references. **U.S.A.**

### 95-1962

#### **Compost as an adsorbent for the treatment of hexavalent chromium.**

D. C. SHARMA (Birmingham University) and C. F. FORSTLER  
*Process Safety and Environmental Protection* 1994, 72, No B4, 234-240

The performance of coconut fibre based potting compost was examined for adsorbing chromium(VI) from aqueous solutions at 25, 50, 100 and 200 mg chromium per litre concentrations and a pH range of less than 2 to 10. As the compost dose increased, the percentage chromium removal increased with the optimal removal efficiency occurring at pH 2.0. Under these conditions, optimal removal was achieved at a chromium concentration of 200 mg per litre and a compost dose of 12 g per litre. The kinetic results indicated that the adsorption process followed a second order reaction rate with the lower concentrations being removed more efficiently and at a much higher rate. The process was economically viable due to the fact that the compost was less expensive than activated carbon. **U.K.**

### 95-1963

#### **Ozonation of wastewaters containing organometallic complexes of lead.**

K. FOUKAY (Ecole Polytechnique de Montreal, P.Q.), R. HAUSER, F. G. BRIERE, D. DAGENAIS and F. PARROT  
*Sciences et Techniques de l'Eau*, 1994, 27, No 4, 30-33 (in French, English summary)

Samples of industrial effluent heavily contaminated with lead (185 mg per litre) in the form of organometallic complexes were subjected to a pre-ozonation treatment to enhance the lead-removal efficiency of the conventional coagulation-flocculation treatment. The results

from ozonation followed by coagulation with ferric chloride in batch reactors, assisted by a flocculation/flotation treatment, indicated that a residual lead content of only 0.15 mg per litre could be achieved compared with 2 mg per litre using ferric chloride coagulation and flocculation alone. Some of the enhanced removal might be associated with capture of microscopic lead particles by the foam layer produced during the ozonation treatment, suggesting that foam formation should be encouraged rather than suppressed if maximal lead removal efficiency was to be realized. (English translation 125 pounds sterling, valid for 1995). **Canada**

### 95-1964

#### **Removal of trace Cd(II) from aqueous solutions by fungal adsorbents: an evaluation of self-immobilization of *Rhizopus oryzae*.**

C. HUANG (National Chiao Tung University, Hsin chu) and H. H. CHIU

*Water Science & Technology* 1994, 30, No 3, 245-253

*Rhizopus oryzae* was cultivated and grown in the form of particles of different sizes in fermenters. The effects of agitation intensity and pellet size were studied. The effects of particle size of pelletized mycelium on the adsorption of cadmium from water were investigated. Kinetics of cadmium adsorption by native, acid-washed and heat treated *R. oryzae* pellets were examined. Suspended mycelium had a higher adsorption rate than the immobilized/pelletized mycelium. Acid washing had no effect on cadmium uptake. Heat treatment decreased cadmium uptake. The optimal pellet size was 3 mm, formed in the fermenter at 300 rpm of agitation. **Taiwan**

### 95-1965

#### **Passive treatment of acid mine drainage with limestone**

R. S. HEDIN (U.S. Bureau of Mines, Pittsburgh, Pa.), G. R. WATZLAFF and R. W. NAIRN

*Journal of Environmental Quality* 1994, 23, No 6, 1338-1345

The performance was evaluated of 2 anoxic limestone drain (ALD) systems constructed to add bicarbonate alkalinity to flow through acid mine drainage waters. Water quality data recorded at the ALD effluents and at wells within the limestone beds during 18-30 month monitoring programmes showed that treatment in the Howe Bridge ALD increased pH by 0.5 units, alkalinity by 128 mg per litre and calcium by 53 mg per litre but there was little change in initial concentrations of ferrous iron (279 mg per litre) and manganese (4 mg per litre) indicating little dilution by uncontaminated water. At the Morrison ALD with initial concentrations of 216 mg ferrous iron per litre and 51 mg manganese per litre, an average 17 per cent decrease in manganese, magnesium, potassium and sulphate was attributed to dilution. Iron decreased by 30 per cent and the equivalent of 249 kg iron was estimated to be retained within the ALD. Alkalinity and calcium increased by 248 and 111 mg per litre, respectively. Both mine waters had relatively high carbon dioxide pressures which enhanced calcite dissolution in the first half of the ALD where most changes in mine water chemistry occurred. Calcite dissolution rates at Howe Bridge and Morrison were 17.9 and 2.7 kg per d, respectively and both ALD had a theoretical lifetime of more than 20 years. Passive treatment of mine waters in ALD systems improved metal removal in downstream constructed wetlands. **U.S.A.**

95-1966

**Studies of the separation of heavy metals from wastewater using freshly prepared magnetite.**

S. CHOI (Technische Universität Hamburg Harburg) W. CALMANO, and U. FORSTNER

*Acta Hydrochimica et Hydrobiologica*, 1994, 22, No 6, 254-260 (in German, English summary)

Experiments were performed to achieve a more effective removal of heavy metals from electroplating plant wastewaters of sorption onto magnetite. In contrast to previously-reported methods such as the ferrite process, the magnetite preparation and the coagulation stages were performed separately to assess the feasibility of improved metal removal without any increase in temperature or oxidation by air. Pure magnetite could be prepared by mixing a ferrous salt solution with an equivalent amount of sodium hydroxide at room temperature. The addition of this artificially produced magnetite sludge to the electroplating plant effluent resulted in a better degree of removal and a lower volume of metal-containing sludge than the use of sodium hydroxide. For nickel the residual level of nickel in the supernatant was reduced to 0.5 mg per litre after only 20 minutes, and for copper the concentration was reduced to only 34 µg per litre. The improved separation performance was attributed to a combination of sorption and coagulation/flocculation effects. The use of magnetite prepared in this way is proposed as a means of enhancing the performance of high gradient magnetic separation treatments, in preference to powdered magnetite. (English translation 240 pounds sterling valid for 1995) Germany

95-1967

**Development of a bioreactor system for the treatment of chromate wastewater using *Enterobacter cloacae* H01**

K. FUJIE (Yokohama National University) T. TSUCHIDA, K. UENO, and H. OHTAKE

*Water Science & Technology*, 1994, 30, No 3, 235-243

A novel bioreactor system was developed for the treatment of wastewaters containing toxic chromate and high strength organic pollutants. *Enterobacter cloacae* strain H01 was introduced into the reactor to remove chromate by reducing it to trivalent chromium. The growth and chromate reducing characteristics of strain H01 were studied. Cultivation of H01 with aeration increased the chromate reduction rate in the bioreactor. The oxidation-reduction potential affected the specific growth rate of H01. Chromate and organic compounds in artificial wastewater and metal plating wastewater were satisfactorily removed in the reactor. Japan

95-1968

**A model for calculating the steady state flux of organic ultrafiltration membranes for the case of cutting oil emulsions**

M. BEL KACEM (Institut National des Sciences Appliquées Toulouse) D. HADJILY and Y. AURELLI

*Chemical Engineering Journal*, 1995, 56, No 2, 27-32

This model provides a basis for the design of cross flow ultrafiltration processes for removing chemical and mechanical emulsions present in wastewater. It gives the resistance of the polarization layer in terms of the pressure drop across the membrane, the velocity of the feed fluid in the membrane module, the viscosity and the density of the emulsion, and was used to compare experimental results obtained with SAREL-A cutting oil emulsions in an ultrafiltration rig. France

95-1969

**Biological treatability of amine laden refinery waste**

N. M. CHONG (Da Yeh Institute of Technology (Chang-Hwa) Water Science & Technology, 1994, 30, No 3, 21-28

Amines are used in the desulphuration process in the petroleum industry. The biological treatment of amine laden refinery wastewater was studied using shake flasks and laboratory scale continuous flow activated sludge reactors for acclimating activated sludge to amine, and for long-term treatment of amine and amine laden wastewater respectively. In the shake flasks, diethanol amine and diisopropanol amine had a prolonged lag time when first inoculated with indigenous activated sludge. In a continuous flow reactor treating ethanol amine there was a 93 per cent COD removal and 98 per cent nitrification but the system was unstable due to bulking. The bulking problem could be corrected using influent consisting of constituents that generate settleable sludge during activated sludge treatment. A mean cell residence time of 5 d should be maintained for the safe treatment of amine. Taiwan

95-1970

**Removal of VOC's from refinery and petrochemical wastewaters using dissolved air flotation**

S. AL MUZAINI (Kuwait Institute for Scientific Research, Safat) H. KHORDAGUI and M. F. HAMOUDA

*Water Science & Technology*, 1994, 30, No 3, 79-90

The Shuaiba Industrial Area (SIA) Kuwait generated 35 000 m<sup>3</sup> industrial waste per d which was discharged untreated or partially treated to the Arabian Gulf. Volatile organic compound (VOC) emissions from SIA's industrial wastewater were characterized in order to design a central wastewater treatment system. Benzene, toluene and ethylbenzene were identified. The total VOC emission of these compounds was 0.1-3.2 mg per m<sup>3</sup>. A pilot plant was constructed to investigate the removal of VOC from wastewaters by dissolved air flotation and granular activated carbon treatment. The effects of detention time and VOC loading on stripping efficiency were evaluated. Up to 20 per cent of influent VOC were lost by volatilization at an air/water ratio of 0.5. Adsorption by dry granular activated carbon led to the removal of 81.7 per cent benzene and 99 per cent of other VOC. Coupling covered dissolved air flotation units with dry activated carbon columns was recommended to minimize occupational exposure to VOCs. Kuwait

95-1971

**Waste minimization and pollution prevention at a plutonium processing facility.**

K. K. S. PILLAI (Los Alamos National Laboratory, N. Mex.) *Waste Management*, 1994, 14, No 7, 613-620

The Los Alamos National Laboratory had established a research and development programme with the aim of processing plutonium with little or no impact on the environment, and in this context had identified technologies that were promising in terms of waste minimization and pollution prevention. Essentially, waste stream polishing to remove final traces of plutonium and hazardous chemical constituents could be achieved through process modifications, the use of alternative chemicals and sorbents for residue removal, acid recycling and the use of a variety of waste polishing techniques. In an example, high magnetic field separation of paramagnetic actinide particulates and freeze drying were promising for the removal of residual amounts of plutonium as fine colloidal particles in liquid streams which could not be removed by conventional ion exchange or filtration processes. U.S.A.

## EFFECTS OF POLLUTION

95-1972

### **Sorption of caesium on bentonite.**

S. A. KHAN (Punjab University, Lahore), R. ur REHMAN, and M. A. KHAN.

*Waste Management*, 1994, 14, No. 7, 629-642.

The sorption capability of local bentonite relative to caesium-134 was examined in terms of such parameters as contact time, pH, sorbent, sorbate and complementary cation and organic ligand concentrations. Thus, over a pH range of 1.5 to 11, the caesium sorption by the bentonite increased as the pH increased. Moreover, the caesium uptake by the bentonite increased as the bentonite concentration increased due to the greater availability of exchange sites at the higher bentonite concentrations. There was evidence to suggest that some organic complexing agents such as EDTA, and certain natural ligands (including oxalic and citric acids) affected caesium sorption such that the higher the concentration of the ligand, the greater the sorption reducing effect. There are 34 references.

Pakistan

95-1973

### **Zeolites for nuclear waste treatment: Co, Ni, Z uptake into synthetic faujasites X & Y: I. pH effects, calcination, elution and encapsulation studies.**

A. DYER (Salford University), and J. K. ABOU-JAMOUS.

*Journal of Radioanalytical and Nuclear Chemistry*, 1994, 183, No. 2, 225-233.

Two synthetic faujasite zeolites, designated X and Y, were examined with respect to their uptake of cobalt, nickel and zinc radioisotopes. Distribution coefficients were obtained with and without competing cations at various pH values. Elution was studied with zeolites containing cobalt, nickel and zinc radioisotopes, taking account of the effect of acid and alkaline conditions, calcination and encapsulation in cement. Leach rates arising from the study were calculated. Zeolites X and Y were suitable for decontamination of aqueous wastes containing the isotopes studied. Cement encapsulation was helpful, but calcination offered no advantages. U.K.

## EFFECTS OF POLLUTION

See also Abstracts 95-1670, 95-1673, 95-1685, 95-1687, 95-1692

95-1974

### **An assessment of the risks associated with PCDDs and PCDFs following the application of sewage sludge to agricultural land in the UK.**

A. P. JACKSON (Environmental Resources Management, Oxford), and G. H. EDULJEE.

*Chemosphere*, 1994, 29, No. 12, 2523-2543.

A model was developed to predict the transfer of polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) from sewage sludge-treated soils to the human food chain. Predicted concentrations of PCDD and PCDF in potatoes, cereals, root and leaf vegetables were in close agreement with concentrations reported by the Ministry of Agriculture, Fisheries and Food. Assuming a half-life of 10 years in sludge-treated soils, and 10 years of application of rurally sourced sludge, the total exposure of an individual whose diet is derived solely from sludge-treated soils would be 2.6 pg international toxic equivalents (I-TEQ) per kg.d. This is lower than the Tolerable Daily Intake of 10 pg I-TEQ per kg.d recommended by the U.K. government. U.K.

95-1975

### **Soil, groundwater, and bigtooth aspen sapling : in sludge-treated**

J. P. HART (Michigan State University, East Lansing), and P. V. NGUYEN.

*Journal of Environmental Quality*, 1994, 23, No. 6, 1257-1264.

Approximately 10 Mg dry, anaerobically-digested municipal sludge per ha containing 590, 300, 27, 420 and 481 kg nitrogen, phosphorus, potassium, calcium and magnesium per ha, respectively was applied to 35 m<sup>2</sup> plots in a 10-year-old coppice bigtooth aspen (*Populus grandidentata*) stand and subsequent changes in the ecosystem were monitored for 4 years. Sludge fertilization resulted in increased nutrient concentrations in the forest floor but not in surface or subsurface soils. The sapling growth responses to sludge application were comparable to those reported previously and no detrimental effects on tree regeneration were observed. Soil leachate contained an average of 7.64 mg nitrate-nitrogen per litre with a maximal value of 28.83 mg per litre. Data from 5 monitoring wells showed that following sludge application groundwater nitrate-nitrogen concentrations reached a peak of 4.3 mg per litre during the first snowmelt of the second year and then rapidly diminished to approach background levels. No groundwater samples exceeded the potable water standard of 10 mg nitrate-nitrogen per litre. The results indicated that the ecosystem would continue to adjust towards natural levels of plant nutrient concentrations, physiological processes and growth. U.S.A.

95-1976

### **Assessment of salinity-related mortality of freshwater bacteria in the Saint Lawrence estuary.**

J. PAINCHAUD (Universite Laval, P.Q.), J. C. THERRIault, and L. LEGENDRE.

*Applied and Environmental Microbiology*, 1995, 61, No. 1, 205-208.

A methodology involving the combined use of dilution cultures and diffusion chambers was used to study the growth response of freshwater bacteria from the St. Lawrence river exposed to brackish waters from the upper estuary. The growth of freshwater bacteria was reduced by 15 and 50 per cent after exposure to salinities of 10 and 20 ppt, respectively. At lower salinities, no growth reduction was observed. A salinity of 2 ppt even stimulated growth. The longitudinal distribution of bacterial abundance peaked at this salinity. The results suggested that the decline of bacterial abundance in the low-salinity waters of the estuary was not caused by salinity-related mortality of freshwater bacteria. U.S.A.

95-1977

### **Invertebrate community responses to physical and chemical factors at the river/aquifer interaction zone: I. Upstream from the city of Lyon.**

S. PLENET (Universite Claude Bernard, Lyon), and J. GIBERT.

*Archiv fur Hydrobiologie*, 1994, 132, No. 2, 165-189.

An assessment was conducted into the effects that individual chemical and physical parameters in the Rhone river basin might have on the distribution on species and the community structure at the interaction zone between surface and aquifer. The data were gathered from 7 sites on the Rhone river and Ain river in south-eastern France in the period April to June 1991. Multivariate statistical community analysis and parameters such as abundance, richness and diversity indices indicated that the composition of surface and interstitial communities were related to some extent to some of the chemical factors and variations in metal concentrations in water or sediments.

In particular, magnesium, potassium sulphate, oxygen and metal concentrations could be associated with faunal populations. Sites with zinc or copper contamination generally had lower diversity and lower numbers of individuals. The variations found between invertebrate sensitivities to trace metals, particularly for hypogean species, suggested that consideration of their use in trace metal biomonitoring would be premature. There are 83 references. France

95-1978

**Gradients of subsurface water toxicity to oyster larvae in bays and harbours in California and their relation to mussel watch bioaccumulation data.**

B. KONAR (California State Department of Fish and Game, Moss Landing) and M. D. STEPHENSON (*Chemosphere*, 1995, 30, No 1, 165-172)

Sub-surface water samples from several harbours were examined by 48-h toxicity tests on *Crassostrea gigas* larvae at 20‰ and 34 ppt salinity. After the test the proportion of abnormal larvae, defined as those which failed to develop into the predissoconch I stage, was measured. The results were compared by linear regression with metal and chlorinated organic compound contaminant levels. In some harbours, increasing toxicity coincided with rising tissue concentrations of lead, copper, silver, zinc, chlordane, endosulphan, dieldrin and PCB. There were no correlations in other harbours. No significant relationships were established when all the data were pooled. Both bioassay and chemical analyses of contaminants were needed to assess toxicity in these locations. U.S.A.

95-1979

**Histopathology of kidney of *Channa punctatus* exposed to chronic nonlethal level of Elsan, mercury and ammonia**

S. BANERJEE (Visva Bharati University, Santiniketan, West Bengal) and S. BHATTACHARYA

*Ecotoxicology and Environmental Safety*, 1994, 29, No 3, 265-275. *Channa punctatus* were exposed to Elsan (211 ppb), mercuric chloride (16.7 ppb) and aqueous ammonia (15.64 ppm) to investigate histopathological changes in head and trunk kidneys on 7, 28, 63 and 90 d of exposure. The head kidney showed degeneration and dispersion of interrenal and chromaffin tissues and necrosis in haemopoietic elements. Fish exposed to Elsan and mercury had kidney lesions throughout the entire experimental period. Lesions due to ammonia healed during the first phase of treatment. Abnormalities in trunk kidneys included renal lesions consisting of minimal to mild multifocal, acute tubular epithelial degeneration, karyolysis and dilation or shrinkage of Bowman's capsule and glomerulus. Elsan and mercury treatment gave a highly significant decrease in dimension of Bowman's capsule and glomerulus at all sampling days except day 28. With ammonia there was a significant reduction in the size of Bowman's capsule and glomerulus throughout the experimental period except at day 28. On day 28 there was little dilation of Bowman's capsule and a significant dilation of glomerulus. India

95-1980

**Anakeesta stream acidification and metal contamination effects on a salamander community**

D. J. KUCKEN (North Carolina University, Asheville), J. S. DAVIS, J. W. PETRANKA and C. K. SMITH

*Journal of Environmental Quality*, 1994, 23, No 6, 1311-1317. The microhabitats, density and age structure of Appalachian streamside forest salamander communities were determined in 3 plots affected by a 15-year-old Anakeesta rock road fill which released a toxic leachate containing ferrous sulphate, sulphuric acid and metals

and in 5 uncontaminated plots. In contaminated plots species with aquatic larval stages (*Desmognathus quadrimaculatus* and *Eurycea wilderae*) were almost completely eliminated while the numbers of species using both streams and seepages for breeding (the *Desmognathus* or *hyphnoides* complex) were reduced from approximately 63 to 35 animals per plot. Terrestrial breeding species (*Plethodon jordani* and *Desmognathus wrightii*) were significantly more abundant on impacted plots than on control plots. There was no evidence of shifts in microhabitat use due to Anakeesta exposure but an increase in the abundance of *P. jordani* juveniles from 26 per cent of the population in control plots to 48 per cent in impacted plots was probably due to the absence of predation by *D. quadrimaculatus* and reduced competition by stream breeding adults. Stream contamination resulting from Anakeesta exposure had direct and indirect effects on streamside salamander communities and species with biphasic life cycles were useful indicators. There are 39 references. U.S.A.

95-1981

**The effect of catchment liming on bryophytes in upland Welsh streams, with an assessment of the communities at risk**

S. M. WILKINSON (Wales University, Cardiff) and S. J. ORMEROD

*Aquatic Conservation*, 1994, 4, No 4, 297-306

Six upland streams were surveyed for aquatic bryophytes during 1987-1993 and 3 catchments limed experimentally in 1987-1988. Nine further streams were surveyed over the period to obtain more knowledge of the bryophyte communities where liming might subsequently occur. Transformed data were analysed by analysis of variance. Twenty-nine bryophyte species were noted on the wetted margins of the 15 streams; the percentage cover for most species was below 5 per cent, apart from *Nardia compressa* which reached 71 per cent. This species declined substantially in lime-treated streams and no other species increased to replace it. In general, total bryophyte cover fluctuated from year to year and masked any responses to liming which might have occurred. Implications for invertebrates would need to be considered where catchment liming was proposed. There are 30 references. U.K.

95-1982

**Subacute toxicity of ammonia to Atlantic salmon (*Salmo salar* L.) in seawater: effects on water and salt balance, plasma cortisol and plasma ammonia levels**

M. B. KNOPH (Norwegian College of Veterinary Medicine, Oslo) and Y. A. OLSEN

*Aquatic Toxicology*, 1994, 30, No 4, 295-310

Atlantic salmon (*Salmo salar*) postsmolts weighing 300 g were exposed to sublethal ammonia levels (less than 1-100 µg ammonia per litre) in running seawater for 5 weeks. Plasma cortisol was analysed as a primary stress response indicator. Skeletal muscle tissue water content and blood plasma osmolality and ion levels were analysed as indicators of water and salt balance disturbance. Plasma cortisol was significantly increased at all water ammonia levels above control after 2 weeks of exposure but the levels were low and did not increase with increasing ammonia levels. No effects were found on muscle tissue water content or plasma sodium or magnesium levels. For skeletal muscle tissue water content, plasma osmolality and ion levels, the lowest observed effect concentration was 81 µg per litre after 2 weeks and 100 µg per litre after 5 weeks of exposure. There are 56 references. Norway

## EFFECTS OF POLLUTION

95-1983

### Effect of pH on the distribution and occurrence of aquatic fungi in six West Virginia mountain streams.

T. DUBEY (Northern Illinois University, De Kalb), S. L. STEPHENSON, and P. J. EDWARDS

*Journal of Environmental Quality*, 1994, 23, No 6, 1271-1279

Aquatic fungi were sampled in 3 streams with water pH above 5.9 and 3 more acidic streams using various types of organic bait and leaf bags and by membrane filtration of streamwater to extract conidia. The stream mycoflora consisted of 156 taxa including 47 zoospore fungi (24 chytridiaceous fungi and 23 water moulds), 60 Ingoldian hyphomycetes and 49 non-Ingoldian hyphomycetes. The number of zoospore taxa ranged from 27 in the stream with the highest pH (7.9) to 15-18 taxa in all other streams (pH 3.2-6.0) indicating wide tolerance to pH. Ingoldian hyphomycetes taxa also increased with streamwater pH, red oak (*Quercus rubra*), sugar maple (*Acer saccharum*) and red maple (*Acer rubrum*)/beech (*Fagus grandifolia*) leaf bags were colonized by 16.0, 15.3 and 15.2 hyphomycete taxa, respectively. The distribution pattern for non-Ingoldian hyphomycetes was less clear and the number of filtered conidia decreased at both extremes of the pH gradient. Aquatic fungi could be useful indicators of the biological integrity of acidified stream ecosystems. There are 67 references. U.S.A.

95-1984

### Toxicity of metal-contaminated sediments from the upper Clark Fork river, Montana, to aquatic invertebrates and fish in laboratory exposures.

N. E. KEMBLE (Midwest Science Center, Columbia, Mo.), W. G. BRUMBAUGH, E. L. BRUNSON, F. J. DWYER, C. G. INGERSOLL, D. P. MONDA, and D. F. WOODWARD

*Environmental Toxicology and Chemistry*, 1994, 13, No 12, 1985-1997

Sediments of the upper Clark Fork river, Mont., U.S.A., were contaminated with arsenic, cadmium, copper, lead, manganese and zinc from mining activities. The toxicity of pore water from these sediments was determined using *Daphnia magna* (48 h exposure), rainbow trout (*Oncorhynchus mykiss*) (96 h exposure), and Microtox. Whole-sediment toxicity tests were conducted with *Hyalella azteca* (28 d exposure), *Chironomus riparius* (14 d exposure), *D. magna* (2- to 22-d exposure). The toxicity of pore water samples was reduced with 5-7 d of storage relative to 1 d of storage. Whole-sediment samples from Milltown reservoir and the Clark Fork river were toxic to amphipods, midges, and rainbow trout but not to daphnids. The sensitivity of the organisms in whole sediment toxicity tests decreased in the order: *H. azteca*, *C. riparius*, *O. mykiss*, *D. magna*. The relative sensitivity of the 3 end points evaluated with *H. azteca* decreased in the order: length, sexual maturity, survival. Factors controlling metal bioavailability are discussed. There are 40 references. U.S.A.

95-1985

### Physiological changes and tissue metal accumulation in rainbow trout exposed to foodborne and waterborne metals.

A. M. FARAG (Wyoming University, Laramie), C. J. BOESE, D. F. WOODWARD, and H. L. BERGMAN

*Environmental Toxicology and Chemistry*, 1994, 13, No 12, 2021-2029

Sediment from the upper Clark Fork river, Mont., U.S.A., was contaminated with metals from mining activities. Sublethal physiological effects (necropsy assessment, ionoregulatory dysfunction, oxidative stress) and metal residue accumulation in tissues were

measured in rainbow trout (*Oncorhynchus mykiss*) fed a metal-contaminated diet and/or exposed to waterborne metals for 21 d. Consumption of metal-contaminated food affected scale loss and metal accumulation in gut tissue of adult trout. Exposure to waterborne metals affected survival, scale loss and metal accumulation in gill and kidney tissue. Combined dietary and waterborne exposure caused lipid peroxidation in the kidney of adult fish and decreased whole-body potassium of juvenile trout. The importance of the dietary pathway for metal exposure of fish in the Clark Fork river was demonstrated. There are 34 references. U.S.A.

95-1986

### Population and community effects of sediment contamination from residential urban runoff on benthic macroinvertebrate biomass and abundance.

A. E. CASPER (Southern Illinois University, Carbondale)

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 6, 796-799

Macroinvertebrates and sediment samples were collected from a lake with 2 sub-basins: one of which received runoff from a residential area (sub-basin R), the other from a vegetated area (V). Sediment samples were analysed for trace metals, and manganese, lead and zinc concentrations were found to be significantly higher in R. Macroinvertebrates were identified, and abundance per m<sup>2</sup> and total g wet weight of the taxa per sample site were determined. Fifteen taxa were found in R and 11 in V, and total site abundance and total site biomass were greater in R. The pollution intolerant predator *Sialis* was more abundant in V, but 6 pollution tolerant taxa were more abundant in R. U.S.A.

95-1987

### Dietary and waterborne exposure of rainbow trout (*Oncorhynchus mykiss*) to copper, cadmium, lead and zinc using a live diet.

D. R. MOUNT (ENSR Consulting and Engineering, Fort Collins, Colo.), A. K. BARTH, T. D. GARRISON, K. A. BARTEN, and J. R. HOCKETT

*Environmental Toxicology and Chemistry*, 1994, 13, No 12, 2031-2041

The effects of 60-d exposure of rainbow trout (*Oncorhynchus mykiss*) fry to diets of brine shrimp (*Artemia* sp.) nauplii contaminated with copper, cadmium, lead and/or zinc were investigated. Dietary concentrations fed to trout were selected based on metal concentrations measured in invertebrates collected from the Clark Fork river, Mont., U.S.A. All fish receiving metal-enriched diets were also exposed to a mixture of metals at sublethal concentrations in the water. In all treatments, fish showed increased tissue metal concentrations. Survival and growth were unaffected by dietary concentrations up to 55, 170, 350, and 1500 µg per g dry weight for cadmium, lead, copper, and zinc, respectively. Fish fed copper concentrations above those found in the river (660 and 800 µg per g dry weight) showed 30 per cent mortality but there was no effect on growth. There are 33 references. U.S.A.

95-1988

Toxicity of cadmium, hexavalent chromium and copper to marine fish larvae (*Cyprinodon variegatus*) and copepods (*Tisbe battagliai*).

T. H. HUTCHINSON (ZENECA Limited Brixham) T. D. WILLIAMS, and G. J. EALES

*Marine Environmental Research*, 1994, 38, No 4, 275-290

Toxicity tests were performed on newly hatched larva of *Cyprinodon variegatus* and on adult females with egg sacs and nauplii of *Tisbe battagliai*. Toxicity of cadmium, chromium(VI) and copper to fish was measured by survival and growth rates over 7 d and to copepods by survival and reproduction over 8 d exposure. For fish larva, 96 h LC50 values were 1.23, 31.6 and greater than 0.22 mg per litre for cadmium, chromium and copper respectively. Subchronic values (SCV) were 0.75, 24.0 and 0.16 mg per litre respectively. For copepod nauplii and adults, 96 h LC50 values for cadmium were 0.46 and 0.34, for chromium 1.60 and 5.9, and for copper 0.064 and 0.088 mg per litre respectively. SCV for naupliar survival and adult survival or reproduction after 8 d were 0.024, 0.42 and 0.008 mg per litre for cadmium, chromium and copper. There are 39 references.

U.K.

95-1989

Effect of pH and time on the acute toxicity of copper sulphate to the ciliate protozoan *Tetrahymena thermophila*

D. SCHLEFNK (Arkansas University for Medical Science, Little Rock) and C. T. MOORE

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 6, 800-804

Cultures of *Tetrahymena thermophila* were exposed to 10 µM of cadmium chloride or copper sulphate for 24 h. Cadmium caused 100 per cent lethality, but copper caused 98.5 per cent (significantly different). In subsequent studies, copper sulphate concentrations of 10 ppm were applied at pH values of 6, 7 or 8 for 24-96 h. At pH 7 the LC50 decreased by 30 per cent from 24 to 96 h. As pH increased from 6 to 8 lethality generally decreased, but lethality from concentrations above 3 ppm was greater at pH 7 than at pH 6 or 8. *T. thermophila* appears relatively resistant to copper toxicity, with the greatest toxicity at a pH range where metal uptake would be maximal. An intracellular mechanism was probably responsible for the resistance. U.S.A.

95-1990

Changes in oxidative metabolism in selected tissues of the crab (*Scylla serrata*) in response to cadmium toxicity

P. SREENIVASULA REDDY (Pondicherry University) and A. BHAGYALAKSHMI

*Ecotoxicology and Environmental Safety*, 1994, 29, No 3, 255-264. *Scylla serrata* were exposed to a sublethal concentration (2.5 ppm) of cadmium chloride and the following observations made. There were increases in lactate levels in hepatopancreas and muscle, haemolymph sugar levels, phosphorylase, glucose-6 phosphate dehydrogenase, acid and alkaline phosphatase, ammonia, urea and glutamine levels, protease, alanine aminotransaminase, aspartate aminotransaminase, glutamate dehydrogenase, AMP deaminase, adenosine deaminase, arginase and glutamine synthetase. There were decreases in glycogen, total carbohydrates and pyruvate in hepatopancreas and muscle, lactate, succinate and malate dehydrogenase, cytochrome c oxidase, and magnesium ATPase protein and free amino acid. This showed that cadmium affected oxidative metabolism and induced hyperammonemia with *S. serrata* switch

ing over their metabolic profiles towards compensatory mechanisms for survival in cadmium polluted habitats. There are 51 references.

India

95-1991

A decade-long perspective on a bioindicator of pollution: imposex in *Hymanassa obsoleta* on Cape Henlopen, Delaware bay.

L. A. CURTIS (Delaware University Newark)

*Marine Environmental Research*, 1994, 38, No 4, 291-302

Imposex (imposition of male characters on female gastropods) was determined by dissection of 1686 estuarine gastropods, *Hymanassa obsoleta*, collected in 1992 from 1400 m of shoreline on the Cape Henlopen sandflat, Delaware bay. Data gathered since 1981 were also assessed. Imposex occurred throughout the habitat at variable frequency (0-64 per cent) at 44 locations. Intensity of expression was slight. Imposex frequency increased from 1 per cent in 1981 to 30 per cent in 1992. There was a weak correlation between percentage imposex, position on the sandflat and treated parasitism. Samples collected furthest from the beach and with a larger proportion of females parasitized tended to have fewer imposed females. Lower intertidal microhabitats might be exposed to less imposex inducing agents (organotin pollution) than higher locations. U.S.A.

95-1992

Calculating the aquatic toxicity of hydrocarbon mixtures.

D. R. PETERSON (Exxon Biomedical Sciences, Inc., Millstone, NJ)

*Chemosphere*, 1994, 29, No 12, 2493-2506

Different hydrocarbons are equally toxic to aquatic organisms, based on the concentration within the organism, but differences in equilibrium partitioning between water and the organism results in differences in measured toxicity. For hydrocarbon mixtures, there is an additional variability due to partitioning between the bulk hydrocarbon and water. Equations were developed to calculate the concentrations of hydrocarbons in water over a range of water to hydrocarbon mixture ratios. The method was applied to a typical petrol, and the results extrapolated to estimate the toxicity of the mixture to aquatic organisms. The results agreed with published toxicity tests, but the method was only applicable to closed laboratory systems because it did not allow for volatilization. U.S.A.

95-1993

Contaminant induced lysosomal membrane damage in marine mussel digestive cells: an *in vitro* study

D. M. LOWE (Plymouth Marine Laboratory) and R. K. PIPER

*Aquatic Toxicology*, 1994, 30, No 4, 357-365

Mussels (*Mytilus edulis*) were exposed to the PAH fluoranthene (100 µg per litre) in acetone or to acetone alone for 7 d. Digestive cells were isolated from mussels by treatment with a calcium/magnesium free saline and addition of trypsin. Electron microscopy indicated that the isolation procedure did not result in any changes in cell morphology. Damage caused by exposure to fluoranthene was assessed using the retention of the cationic diazine probe, neutral red in the lysosomal compartment. A large proportion of the isolated cells from the fluoranthene treatment group had structural alterations including enlarged secondary lysosomes and an increase in the presence of lipid rich droplets. The probe retention time was significantly reduced in the lysosomes of cells isolated from exposed mussels. Total activity of the lysosomal marker enzyme *N*-acetyl-beta-D-hexosaminidase was significantly increased in the exposed animals. U.K.



## EFFECTS OF POLLUTION

95-1994

**Relationship between pollution and susceptibility to infectious disease in the eastern oyster, *Crassostrea virginica*.**

F. L. E. CHU (William and Mary College, Gloucester Point, Va.) and R. C. HALE

*Marine Environmental Research*, 1994, 38, No 4, 243-256

Oysters (*Crassostrea virginica*) were exposed to 0, 15 and 30 per cent dilutions of water soluble fractions (WSF) of pollutants extracted from sediment collected from Elizabeth river, Chesapeake bay and then challenged with the protozoan parasite *Perkinsus marinus* (Dermo). Sediments contained a mean concentration of 2.42 mg PAH per g including fluoranthene, phenanthrene, pyrene, acenaphthene, fluorene, benzo(a)fluorene, chrysene and benzo(a)anthracene. WSF contained more than 100 compounds at a mean concentration of 4.08 mg per litre. Exposure to WSF increased the susceptibility of eastern oysters to disease. Progression of natural latent infections might be enhanced by exposure to environmental contaminants and was correlated with high salinity and temperature. There are 47 references. U.S.A.

95-1995

**Impact of chemigation on selected non-target aquatic organisms in cranberry bogs of British Columbia.**

M. I. WAN (Environment Canada, North Vancouver, B.C.), R. G. WATTS and D. J. MOUL

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 6, 828-835

Stickleback fish (*Gasterosteus aculeatus*) and daphnids (*Daphnia magna*) were placed in cages in the reservoirs and roadside ditches associated with cranberry bogs before the application of insecticides through the irrigation systems. Rainbow trout (*Oncorhynchus mykiss*) did not survive the low pH in preliminary experiments. The *Daphnia* tests were inconclusive because there was a high mortality at the control sites. At the open bog where azinphos-methyl was applied there was 100 per cent stickleback mortality in the 96 h after chemigation at both test sites, but none at the control site. At the closed bog where parathion was used the stickleback mortality was 7 and 3 per cent at 2 test sites and zero at the control site. Stickleback fish appeared to be suitable test organisms for bog environments. Canada

95-1996

**Cytochrome P450IA induction by a coplanar PCB, a PAH mixture, and PCB-contaminated sediment extracts following microinjection of rainbow trout sac-fry.**

M. ENGWALL (Uppsala University), B. BRUNSTROM, A. BRIEFER and I. NORRGREN

*Aquatic Toxicology*, 1994, 30, No 4, 311-324

The 7-ethoxyresorufin (O)-deethylase (EROD) inducing potencies of a coplanar PCB (3,3',4,4',5-pentachlorobiphenyl), a mixture of 5 PAH compounds, and lipophilic compounds extracted from the sediments in a PCB-contaminated lake (Jarnsjon lake) in Sweden and from sediments in lakes up and downstream (Flögen lake and Grönskogsjon lake) from the contaminated lake, were studied in rainbow trout (*Oncorhynchus mykiss*) sac-fry in a 43 d study. The compounds were injected into the yolk sacs of newly-hatched sac-fry and hepatic EROD activity, liver morphology and sac-fry mortality were studied. All the compounds induced hepatic EROD activities. The coplanar PCB led to a 40-fold increase in EROD activity. The extract from Jarnsjon sediment was a more potent EROD inducer than sediments from the other 2 lakes. The highest dose of PAH (10 µg per embryo) caused 90 per cent mortality. Changes in morphology

were observed in liver from embryos injected with Jarnsjon lake sediment extract, the coplanar PCB, and the highest dose of PAH. Sweden

95-1997

**Benzo(a)pyrene hydroxylase activity in the marine mussel *Mytilus galloprovincialis*: a potential marker of contamination by polycyclic aromatic hydrocarbon-type compounds.**

X. MICHAEL (Université de Bordeaux, Talence), J. P. SALAUN, F. GALGANI, and J. F. NARBONNE

*Marine Environmental Research*, 1994, 38, No 4, 257-273

Mussels (*Mytilus galloprovincialis*) collected from Arcachon bay, Bordeaux, were exposed to 3-methylcholanthrene (MC), benzo(a)pyrene (BP) or clofibrate. Optimal conditions for measurement of benzo(a)pyrene hydroxylase (BPH) activity in mussel microsomes were determined. 70 µM BP, 0.75 mg microsomal protein (MP) per 800 µl, 0.74 mM NADPH and 10 minutes incubation time. The reaction was dependent on NADPH concentration and was linear with time. The best compromise between signal to noise and linearity of reaction is considered. BPH induction in mussels treated with MC or exposed to PAH contaminants demonstrated the use of the technique as a potential marker of PAH exposure. There are 47 references. France

95-1998

**Metolachlor and 2,4-dichlorophenoxyacetic acid sensitivity of *Salvinia natans*.**

A. M. GONCZ (Maribor University) and I. SENCIC

*Bulletin of Environmental Contamination and Toxicology*, 1994, 53, No 6, 852-855

Plants of the freshwater fern *Salvinia natans* were exposed to metolachlor at concentrations of 0.01 to 1 mg per litre or to 2,4-dichlorophenoxyacetic acid (2,4-D) at concentrations of 0.01 to 100 mg per litre. Growth, drying and developmental injuries were measured weekly, and biomass and chlorophyll content after 4 weeks. Metolachlor caused most changes to leaf growth and to chlorophyll *a* and *b* content. The apparent EC<sub>50</sub> values varied from 0.075 to 0.55 mg per litre for leaf growth and length of stem, respectively. 2,4-D had an apparent EC<sub>50</sub> of 0.3 mg per litre for chlorophyll *a* and *b*, and 0 mg per litre for the growth measurements. Slovenia

95-1999

**Effects of benzo(a)pyrene and tetrachlorodibenzo(p)dioxin on fetal dolphin kidney cells: inhibition of proliferation and initiation of DNA damage.**

M. J. CARVAN (Texas A & M University, College Station), L. P. FLOOD, B. D. CAMPBELL and D. L. BUSBEE

*Chemosphere*, 1995, 30, No 1, 187-198

Dolphin kidney cells (DKC) were exposed *in vitro* to benzo(a)pyrene (BaP) in the presence or absence of 2,3,7,8-tetrachlorodibenzo(p)dioxin (TCDD) or *alpha*-naphthylamine (NF). TCDD was a cytochrome P450-inducing agent and NF an inhibitor of the induction. BaP inhibited cell mitosis in a dose-dependent manner while TCDD inhibition was less affected by dose. The effects of both substances were decreased by NF. BaP treatment initiated both tritium thymidine incorporation and the increased alkali lability of DNA functions of the initiation of excision repair. Cells pre-treated with TCDD and then exposed to BaP increased BaP-DNA adduct levels and DNA excision repair. DKC metabolized BaP *in vitro* as a function of cytochrome P450-associated activities that BaP metabolites covalently bound to cellular DNA and initiated excision repair. There are 42 references. U.S.A.

95-2000

Effects of fluoranthene on the immunocompetence of the common marine mussel, *Mytilus edulis*.

J. A. COLES (NERC, Plymouth), S. R. FARLEY and R. K. PIPE  
*Aquatic Toxicology*, 1994, 30, No 4, 367-379

The effects of exposure to the PAH fluoranthene (20-400 ug per litre) on the immune function of the mussel, *Mytilus edulis* were investigated. Parameters measured included changes in the number and type of circulating haemocytes, release of superoxide anions, release of degradative enzymes and the percentage of circulating blood cells showing peroxidase and phenoloxidase activity. The total number of circulating haemocytes increased with exposure to fluoranthene, but the relative proportions of eosinophilic and basophilic cells were not changed. Exposure to 400 ug fluoranthene per litre resulted in increases in the percentage of blood cells showing peroxidase and phenoloxidase activity. Fluoranthene at 200 and 400 ug per litre resulted in significant dose-related increases in cytochrome-C reduction. Fluoranthene exposure had no effect on total activity for N-acetyl-beta-D-glucosaminidase and chymotrypsin-like enzyme. The variability in effects on different aspects of the immune response emphasized the need for a multi-assay approach to pollution monitoring. There are 45 references. U.K.

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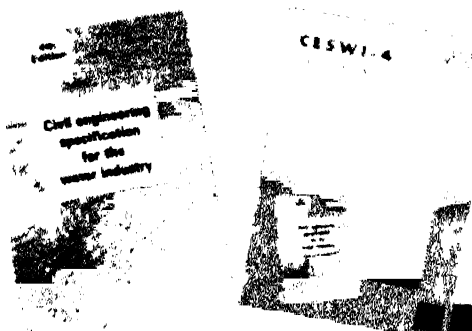
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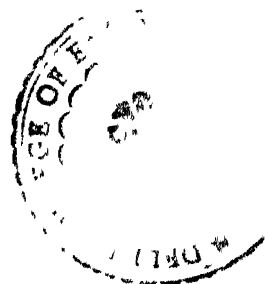
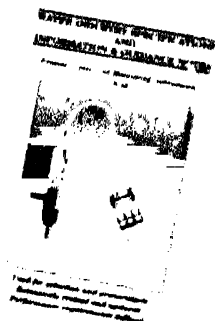
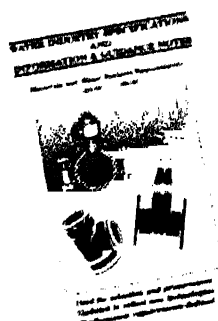
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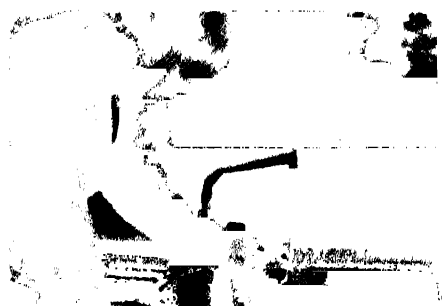
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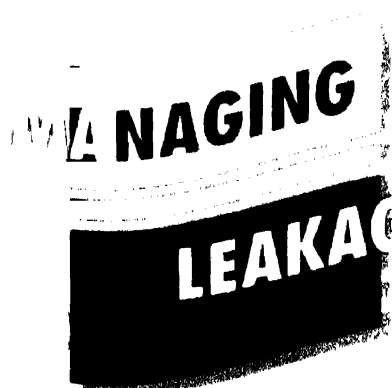


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